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UNDERGRADUATE

Welcome to the 2024-2025 Undergraduate Course Catalog.

While navigating our catalog and exploring course and program offerings, please note that our catalog is designed to display program requirements for the incoming class of students or those who have formally changed their catalog year to 2024-2025. In other words, students pursuing the 2024-2025 academic year requirements should utilize this catalog edition for their program requirements. Students pursing other academic year requirements should reference that corresponding year's catalog. Please see the below definitions for additional information.

Catalog Year: the specific graduation requirements a student is pursuing. The catalog year can be updated for a student in consultation with their academic advisor and with the approval of both the academic dean and Office of the University Registrar within the confines of policy. A student's catalog year may be altered by the university due to a period of non-enrollment.

Catalog Rights: A student has the right to pursue the curriculum associated with the year they begin attending Virginia Tech or a subsequent year as policy allows. Students who defer their attendance forfeit their initial catalog rights.

Admissions Information

Academic Credentials (Minimum First-year Entrance)

Academic preparation for admission to Virginia Tech is best achieved by sustaining an academically rigorous course selection throughout high school. Specifically, students must complete:
18 units of high school coursework, including:

- 4 units of English
- 3 units of math
- 2 units of laboratory science (chosen from biology, chemistry or physics)
- 2 units of social science (one must be history)
- 3 additional academic units (foreign language is highly recommended)
- 4 elective units

By the time they graduate from the university, students must meet a language study requirement. The minimum requirement may be met in middle/high school by completing 2 years of a single foreign or classical language. Some majors in the College of Liberal Arts and Human Sciences and the College of Science may require 3 years. The requirement also may be met after admission by earning 6 semester hours of college-level foreign or classical language credit. American Sign Language will satisfy this requirement.

Complete applications will be reviewed holistically by the Admissions Committee. Factors that are considered in the application review process include:

Academic review:

- Rigor of academic program within context of school
- Grades in courses, including trends over time
- Standardized test scores (if applicable; test-optional for students entering through Fall 2025)
- Major requested on the application (we review by major at Virginia Tech)

Personal review (in alphabetical order, not reflective of order of importance):

- Activities outside of the classroom like jobs, clubs, sports, family responsibilities, service, research, etc.
- Disciplinary record (Virginia Tech reserves the right to deny admission to students who have been dismissed or suspended for academic or disciplinary reasons or to those convicted of a felony or serious misdemeanor.)
- First-generation college student status
- Interest in the Corps of Cadets
- Participation in Virginia Tech pipeline programs
- Personal statements submitted through the Ut Prosim Profile
- Residency
- Veteran status

Recommendation letters and art portfolios are not considered for admissions review.

Competitive freshman applicants will have A/B grades in a rigorous curriculum and strong SAT or ACT scores (if the student chooses to submit scores).

Students who intend to compete in intercollegiate athletics are also required to meet all NCAA and ACC requirements for admission.

Prospective music students must schedule an audition with the music department. Applicants to the music major will receive a form for preferred audition date/time selection or video submission.

Admission (Contact Information and Visitation)

Prospective students and their families are welcome to visit the campus any time the university is in session. The Office of Undergraduate Admissions is open Monday-Friday from 8:00 a.m. to 5:00 p.m. Admission information sessions and student-led walking tours are offered regularly; reservations are required and should be made in the 'Visit' section at https://vt.edu/admissions (https://vt.edu/admissions/) for up-to-date schedule information. Virginia Tech neither requires nor schedules personal interviews for undergraduate admission.

Information on undergraduate admission may be obtained by contacting:

Office of Undergraduate Admissions (https://vt.edu/admissions.html)
Virginia Tech
Blacksburg VA 24061
Phone: 540-231-6267
Fax: 540-231-3242
E-mail: admissions@vt.edu
Web: https://vt.edu/admissions (https://vt.edu/admissions/)

Admission (Freshman Process)

When applying for admission as a freshman, the applicant must send the following materials to the Office of Undergraduate Admissions prior to the deadlines:

1. Official online application and application fee (non-refundable): $60 for first-year, transfer, and non-degree students; $70 for international students. **Please note:** *we expect students to apply online via the Common App; instructions at https://vt.edu/admissions.*
2. Applicants who have only attended high school in the US are required to submit self-reported grades and test scores through the online application process.
3. A final official transcript is requested after admission is offered and the student accepts the offer.
4. Official SAT/ACT scores if student does not apply "test-optional".
5. Discharge certificate (DD214) if the applicant is a veteran.
6. Domicile supporting documents (upon request) if the student is requesting in-state status.

An Early Action option is available to all first-year applicants. The deadline for Early Action application is November 15. Notification of admissions decision for this group is in late February.

First-year applicants applying for Regular Decision must submit a completed application by January 15 and will receive a notification of the admission decision in mid-March. If offered admission, the applicant will receive further instructions to complete the enrollment process. Applicants will have until the national deadline of May 1 to notify Virginia Tech of their decision to accept or decline their admission offer.

Admission (International Applicants)

International applicants for undergraduate admission should apply using the Common App. International student applicants must complete the following courses: 3 units of math (includes algebra and algebra II), 2 units of laboratory science (choose from biology, chemistry, or physics), and additional academic units (foreign language is highly recommended).

International first-year applicants are not required to submit SAT or ACT scores. In addition, international students whose native language is not English must document proficiency in the English language by submitting a TOEFL (Test of English as a Foreign Language) score, IELTS (International English Language Testing System) score, Pearson Tests of English PTE, or Duolingo score. Official copies of all scores must be submitted to the Office of Undergraduate Admissions.

English language requirements and exceptions can be found at https://www.vt.edu/admissions/international/requirements.html. Transfer applicants who have completed two semesters or terms of a non-ESL English composition course with above-average grades at an accredited U.S.-based college or university are not required to submit an English proficiency exam.

Students who have attended high school outside the US for any amount of time may submit the self-reported academic record (SRAR) or transcripts. Non-English transcripts and documents must be submitted in their original form, accompanied by a certified English translation. Unofficial documents and documents without accompanying English translations will not be accepted. Transfer applicants who attended a college or university outside of the US must submit their transcripts for admission review.

All university-level work completed outside the United States must be evaluated by a professional educational credential evaluation service. (A listing of credential evaluators is available at https://transferguide.registrar.vt.edu/Transfer-Requirements.html.) Financial aid is not available for international students at the undergraduate level. All undergraduate international applicants must certify that they have sufficient funds to pay for their education at Virginia Tech prior to being issued an I-20.

All international students holding F-1 and J-1 visas must purchase health and accident insurance.

The Cranwell International Center (https://international.vt.edu/) provides a full range of services to international students at Virginia Tech. Such services include an orientation program especially designed to meet the needs of new international students, as well as immigration counseling and counseling for personal and financial problems. The center also coordinates a variety of cross-cultural programs designed to facilitate interaction between American and international students.

Admission (Non-Degree-Seeking Students)

Virginia Tech makes every effort to provide educational opportunities to individuals who are not seeking a degree from the university, but who wish to continue their education by taking courses at Virginia Tech for college credit or, in some cases, degree credit. Such students include, but are not limited to, students enrolled in other colleges or universities and senior citizens. Non-degree applicants must be in good standing from all previously attended educational institutions with no serious disciplinary infractions. Students will not be competitive for admission if their most recent work is below a 2.0 or their cumulative GPA is below a 2.0.

Students who enroll at Virginia Tech under this program may not be considered candidates for degrees unless they apply formally for regular undergraduate or graduate admission. At that time, minimum requirements must be met and the applicant's academic and disciplinary record at Virginia Tech and all other colleges and universities attended would be reviewed within the context of the current competition for regular admission.

Applying as a Non-Degree-Seeking Student

When applying as a non-degree-seeking student, the applicant must send the following materials to the admissions office:

- Official online application for admission as a non-degree-seeking student (available at https://www.vt.edu/admissions/undergraduate/apply/non-degree-checklist.html) plus a $60 application fee (non-refundable).
- Unofficial transcripts from all colleges and/or universities attended.

The application should be submitted by the published deadline for the term selected (May 1 for Summer, August 1 for Fall, December 1 for Spring). If accepted, the applicant will receive an official notice of admission via e-mail along with other related instructions.

Restrictions on Non-Degree-Seeking Students

- Students who have been denied admission to Virginia Tech as freshmen or transfer students for the same term will not be eligible for reconsideration as non-degree-seeking students.
- Non-degree-seeking students will be able to register on a space-available basis only. Until the deadline for adding classes, such

students may be required to drop a class if the number of degree-seeking students exceeds the number of available spaces in a particular class.
- Non-degree-seeking students will be permitted to attempt up to 30 hours at Virginia Tech, not to exceed 11 hours in any one term during the academic year or 5 hours in either summer school term.
- Non-degree-seeking students are required to maintain an overall GPA of at least 2.0 for continued enrollment.
- Non-degree-seeking students are not eligible for financial aid, scholarships or on-campus housing.
- Students who have previously been enrolled at Virginia Tech may not reapply as non- degree-seeking students. Former students who left the university in good standing may register for classes through Hokie SPA (http://www.hokiespa.vt.edu (http://www.hokiespa.vt.edu/)).

Admission (Transfer Process)

Admission is offered on a competitive basis to transfer applicants with the strongest academic records and with completed courses needed in their intended major.

Competitive applicants will achieve mostly Bs or better. In majors where applications exceed available space, the competitive grades will be considerably higher. Architecture and industrial design are not available for transfer applicants. The most important factors considered for admission are: completion or substantial progress toward completing required, strongly recommended, and recommended courses as stated in our Transfer Admission Roadmaps; and overall GPA in college course work. Transfer Admission Roadmaps are available at: https://www.vt.edu/admissions/transfer/roadmaps.html.

The applicant's overall grade point average and the quality of the student's former academic program are critical factors in admissions considerations. Most transfer applicants who are offered admission have a minimum GPA of 3.0 (on a 4.0 scale). Prospective applicants from the Virginia Community College System will find information about guaranteed admissions agreements at https://vt.edu/admissions/transfer/vccs.html.

Transfer applicants must send the following application materials to the Office of Undergraduate Admissions:

- Official online application and application fee (non-refundable): $60 for first-year, transfer, and non-degree students; $70 for international students. **Please note:** *we expect students to apply online via the Common App; instructions at https://vt.edu/admissions.*
- Applicants are required to submit self-reported grades and test scores through the online application process.
- A final official transcript is requested after admission is offered and the student accepts the offer.
- Discharge certificate (DD214) if the applicant is a veteran.
- Domicile supporting documents if the student is requesting in-state status.

Completed applications are considered and decisions are made by the Admissions Committee. If offered admission, the applicant will receive an official notice of admission and related forms.

Transfer applications for summer/fall admission are due March 1, and students will receive notification of the admissions decision by mid-April. Students offered admission must respond to the offer by June 1 (May 15 for summer entry). Transfer applications for spring admission are due October 1, decisions are posted by mid-November, and responses are due December 1.

Advanced Placement

Through Advanced Placement examinations administered in May of each year by the College Entrance Examination Board, students receiving required scores may be considered for Advanced Placement credit in certain subjects in which they show proficiency. Final determination of credit will be made after the test results have been evaluated by the university. Students must have scores sent directly to the Office of the University Registrar at Virginia Tech (school code 5859) from the College Entrance Examination Board. If scores were not directed to the University Registrar at the time of the examination, contact the College Board at (888) 308-0013.

Credits allowed for advanced placement are shown as transfer hours on Hokie SPA, and may not exceed 38 credit hours. Refer to the Office of the University Registrar's website at https://www.registrar.vt.edu/Transferable-Credit.html for information and to view the AP Credit Table. Questions about Advanced Placement credit should be directed to the Office of the University Registrar at transfercredit@vt.edu.

Advanced Standing

Conditional Advanced Standing refers to an arrangement that permits a student, based on SAT or ACT scores, to place in a course without completing the prerequisite. This process also awards credit for the prerequisite after successful completion of the course. Virginia Tech offers Conditional Advanced Standing for specific English and Math courses based upon the fulfillment of the corresponding requirements. In order to be eligible for advanced standing a student must present SAT or ACT scores. Placement will display on the demographic information page of Hokie Spa prior to orientation.

Advanced standing without credit will be allowed for satisfactory completion of one to five years of study in a foreign language in a secondary school.

Advanced standing with credit will be awarded for students who qualify and meet the criteria as established by university policy. The criteria for the validating courses is it must be the first attempt and a grade of "C-" or better must be earned at Virginia Tech, or a "C" or better in transfer credit. Credit will be awarded automatically at the completion of each semester.

Applying to Graduate School

Students interested in working toward an advanced degree at Virginia Tech should contact the Graduate School for an application (http://www.graduateschool.vt.edu).

Undergraduate Students Enrolling in Graduate Programs or Courses
Virginia Tech offers the opportunity to outstanding undergraduate students (Seniors/Juniors) nearing the end of their bachelor's degree program to enroll and receive credit for coursework taken to apply toward a future graduate program. Seniors with a GPA of 3.0 or better may apply to be admitted to the Dual Student Status for their last semester to take graduate-level courses. Juniors with a GPA of 3.3 or better may apply for admission in the Accelerated Undergraduate/Graduate Degree Program to take graduate courses during the senior year. Please check with your department to check for specific admissions requirements. Information about these programs is available on the Graduate School website (http://www.graduateschool.vt.edu (http://www.graduateschool.vt.edu/))

Undergraduate Students Enrolling in Graduate Programs or Courses

Virginia Tech offers the opportunity to outstanding undergraduate students (Seniors/Juniors) nearing the end of their bachelor's degree program to enroll and receive credit for coursework taken to apply toward a future graduate program. Seniors with a GPA of 3.0 or better may apply to be admitted to the Dual Student Status for their last semester to take graduate-level courses. Juniors with a GPA of 3.3 or better may apply for admission in the Accelerated Undergraduate/Graduate Degree Program to take graduate courses during the senior year. Please check with your department to check for specific admissions requirements. Information about these programs is available on the Graduate School website (http://www.graduateschool.vt.edu)

Taking Graduate-Level Courses

Undergraduate students wishing to enroll in graduate-level courses may do so. You should review any restrictions listed for the course in the Timetable of classes and speak with the faculty member teaching the course to obtain permission. Please note that enrollment in a graduate-level course will not allow you to receive graduate credit for the course if you become a master's or doctoral degree-seeking student without first being admitted to either the Dual or Accelerated Undergraduate/Graduate Degree Program.

Applying to Summer Sessions

Virginia Tech offers the option of two summer sessions of approximately six weeks each or one full twelve-week session. Credit courses on other than the regular time schedule, including intensive courses for teachers, are also offered. The summer sessions program features a comprehensive offering of courses and special programs, including online courses, study abroad programs, and a few undergraduate courses in Northern Virginia.

Enrolled Virginia Tech students, as well as visiting students, are invited to participate in summer sessions. Enrolled students follow the same registration procedure for summer courses as they would for fall and spring. New or visiting students may enroll in summer sessions in either a degree or non-degree status. Such students should visit www.summer.vt.edu (https://www.summer.vt.edu/) for information. Entering freshmen and transfer students should contact the Office of Undergraduate Admissions to be cleared for summer entry. Freshman and transfer applicants wishing to change term of entry to summer should e-mail appchange@vt.edu. Entering graduate students should contact the Graduate School (http://www.graduateschool.vt.edu/).

On-campus housing is available in the summer. For more information, contact 540-231-6207 or housing@vt.edu, or go to www.housing.vt.edu (http://www.housing.vt.edu/).

Summer students have access to most university academic, athletic, and recreational facilities and programs, including the Horticulture Gardens and miles of cycling and walking trails. In addition, the Summer Arts Festival (https://www.performingarts.vt.edu/summer-arts-festival.html) provides free movies, concerts, and exhibits.

Additional information is available at www.summer.vt.edu (http://www.summer.vt.edu/)

Entrance Tests

SAT/ACT scores are optional for all first-year applicants entering through Fall 2025. Tests should be taken such that scores are available before the materials deadline listed at https://www.vt.edu/admissions/undergraduate/apply/dates-and-deadlines.html. The tests are given at centers in Virginia, in all other states, and in many foreign countries. Domestic students will self report their test scores on the self-reported academic record after submitting the online application. International students and students who've attended high school outside the US who wish to report SAT/ACT scores can either self-report or have scores sent directly from the testing agency (SAT: 5859; ACT: 4420). Once offered admission and the applicant accepts the offer, an official test score must be sent directly to the admissions office by the testing agency. Virginia Tech's CEEB number for reporting test scores is 5859. The ACT code is 4420.

International and domestic applicants whose native language is not English are required to provide English proficiency scores from one of the options listed at https://www.vt.edu/admissions/international/requirements.html.

Equal Opportunity / Affirmitative Action Statement

Virginia Tech does not discriminate against employees, students, or applicants on the basis of age, color, disability, gender, national origin, political affiliation, race, religion, sexual orientation or veteran status. Discrimination or harassment on any of these bases is prohibited by Policy 1025 (https://policies.vt.edu/1025.pdf), "Anti-Discrimination and Harassment Prevention Policy."

The university is subject to Titles VI and VII of the Civil Rights Act of 1964, Title IX of the Education Amendments of 1972, Sections 503 and 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act of 1990, the Age Discrimination in Employment Act, the Vietnam Era Veterans' Readjustment Assistant Act of 1974, the Federal Executive Order 11246, Virginia's State Executive Order Number Two, and all other rules and regulations that are applicable.

Those having questions or concerns about Policy 1025, any of these regulations, or related issues should contact:

Virginia Tech Human Resources
Office for Equity and Access
South Gate Center, Ste. 179 (0319)
Blacksburg, VA 24061
(540) 231-9331

International Baccalaureate

Virginia Tech recognizes the International Baccalaureate (IB) diploma or certificate by awarding credit in accordance with institutional policies. The university encourages completion of the IB diploma. Students must have transcripts sent directly to the Office of the University Registrar at Virginia Tech from the IB Board. If scores were not directed to the University Registrar upon completion of the diploma or certificate, refer to the IB website at http://www.ibo.org (http://www.ibo.org/) for information on how to have the results sent.

Score requirements to receive credit may be viewed at https://www.registrar.vt.edu/Transferable-Credit.html

With the IB Diploma, credit is awarded for Higher Level (HL) courses based on minimum scores shown in the HL Credit Table. Credit for only one Standard Level (SL) course is awarded provided the minimum score

shown in the SL Credit Table is earned. A maximum of 38 hours may be awarded.

With the IB Certificate, credit is awarded for Higher Level (HL) courses based on minimum scores shown in the HL Credit Table. No credit is awarded for Standard Level (SL) courses. In addition, no credit is awarded for Theory of Knowledge or Extended Essay. A maximum of 30 hours may be awarded.

Questions about IB credit should be directed to the Office of the University Registrar at transfercredit@vt.edu.

New Student Programs

New Student Programs creates transitional opportunities to prepare new students for academic and co-curricular experiences at Virginia Tech through cultivating an environment that embraces learning, diversity, inclusion, and welcoming of all new Hokies.

Orientation

Orientation at Virginia Tech is a hybrid program that combines virtual experiences and in-person events so students can engage in a variety of ways. During virtual orientation, entering students (first-year, transfer, and international) will complete virtual orientation modules, learn about academics, campus resources, policies, and next steps in their transition to Virginia Tech. Orientation is designed to give incoming Hokies and their guests the information they need to feel confident and comfortable about a collegiate career at Virginia Tech.

Spring Orientation: Students who will enter Virginia Tech in the spring semester will receive information via email regarding the required virtual orientation, where entering spring students will learn about academics, support services, and their next steps in the transition to Virginia Tech.

Information is available at https://students.vt.edu/transition/virtual_orientation.html

Weeks of Welcome

Weeks of Welcome (WoW) is part of the extended orientation and transition experience- and the official start of the Virginia Tech academic experience for new Hokies. Signature events include college and academic sessions (including College Social), residential well-being community days, Living-Learning programming for students residing in an LLC, Hokie Hi spirit rally, transfer student luncheon, international student orientation. Event details are available on the Hokies on Track app.

New Student and Family Programs | 540-231-3284 | https://students.vt.edu/transition.html | orientation@vt.edu

Requirements (Computer)

Virginia Tech requires that entering students have a laptop or tablet computer and strongly recommends the computer meets (or exceeds) the university baseline specifications. Each spring, the university establishes baseline specifications for students entering in the fall of the next academic year. Transfer students are subject to the requirements that were in place for students at the same class level into which they enter. University baseline requirements are listed under the University Studies (undecided) major. If you have declared a major, review the list of specifications for your major. Some majors recommend a different configuration than the minimum outlined by the university. Complete information about the computer requirement can be found online at compreq.vt.edu (https://www.compreq.vt.edu/).

Student Health History

Each student entering Virginia Tech must furnish a health history form, completed by a home physician, for the University Student Health Services. The form will be available online to applicants who accept the offer of admission. Failure to meet Health Services standards may result in dismissal from the university. Information is available at http://www.healthcenter.vt.edu (http://www.healthcenter.vt.edu/).

Transfer Student Credentials Evaluation

For new incoming students, official final academic transcripts from all colleges previously attended should be submitted to the Office of Undergraduate Admissions. Courses from another institution in which a grade of "C-" or lower was earned, and courses taken on a pass/fail or audit basis, are not acceptable for transfer credit. Only grades of "C" or higher in courses consistent with those offered at Virginia Tech are certified for transfer credit. Grades in transfer courses do not transfer or appear on a student's record at Virginia Tech, and are not included in a student's Virginia Tech GPA computation. Credit will be awarded based on Virginia Tech policies.

AP, IB, Cambridge, and CLEP scores should be sent directly to the University Registrar at Virginia Tech from the testing services. Credit will not be awarded from high school transcripts or another institution's transcripts. Refer to the Office of the University Registrar's website at https://www.registrar.vt.edu/Transferable-Credit.html for contact information for testing services and to view the AP, IB, Cambridge, and CLEP Credit Tables.

From two-year colleges (like community college) students can transfer a maximum of 50% of their intended VT degree--which in many cases is 60 credits. From a four-year institution, students can transfer up to 75% of their intended VT degree worth of transferable credit. AP credit has a different "cap" of 38 credits maximum. To receive transfer credit, official academic transcripts from all colleges previously attended should be received in the Office of the University Registrar no later than the end of the first term of the student's first enrollment at Virginia Tech. Class standing will be based upon the number of credits designated as acceptable for meeting graduation requirements. All transfer credits are used in the computation of academic eligibility.

International transfer students are required to submit additional documentation. For a list of required documentation for Admissions see https://vt.edu/admissions/undergraduate/apply/checklists.html. The Office of the University Registrar requires documentation in addition to what is needed for Undergraduate Admissions, in order to evaluate. For the required information please see https://transferguide.registrar.vt.edu/Transfer-Requirements.html

Transfer Policy of Virginia Community College Students

Admission preference shall be given to transfer students who have completed a transferrable A.A., A.S., or A.A.S. (Associate in Arts and Sciences) at the Virginia Community College System or Richard Bland College. While some courses from the Associate of Applied Science degree from a Virginia Community College or Richard Bland College may transfer to Virginia Tech, the Associate of Applied Science degree does not transfer.

Per *State Policy on Transfer*, students who receive their associate degrees from transfer programs at a Virginia Community College or Richard Bland College, based upon a baccalaureate-oriented sequence of courses

appropriate for their major, and are offered admission to Virginia Tech will be granted junior level status upon admission. Additionally, these students will have fulfilled the requirements of the Curriculum for Liberal Education (CLE) or Pathways to General Education, except for departments with specific general education requirements. However, it may take such students longer than two years to complete the baccalaureate degree at Virginia Tech because of major prerequisites and other circumstances or requirements. Transfer students shall have the same opportunities as other students in areas of dining programs, registration, and scholarships and financial aid.

Complete Virginia Tech Transfer Guide (https://www.tranguide.registrar.vt.edu/)

University of Cambridge International Examinations

Cambridge International exams, commonly known as A levels or AS levels, are administered by the University of Cambridge. Virginia Tech recognizes and awards credit for University of Cambridge International Exams based upon the receipt of an official transcript. Students must request an official transcript directly from Cambridge International Examinations or other designated testing agency (Edexcel, etc.) and have this sent to the Office of the University Registrar. Credit will not be considered based on a high school transcript. Credit can be viewed on Hokie SPA under the grades menu. A maximum of 38 credit hours may be awarded.

Refer to the Office of the University Registrar's website at https://www.registrar.vt.edu/Transferable-Credit.html for information and to view the Cambridge Credit Table.

Questions about Cambridge credit should be directed to the Office of the University Registrar at transfercredit@vt.edu

Course Descriptions

Course Descriptions

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A

B

C

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21st Century Studies (C21S)

C21S 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

C21S 2974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

C21S 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

C21S 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

C21S 4004 - Capstone Seminar (3 credits)
Capstone research/project seminar for the minor in C21S. Research skills, engagement with the most recent scholarship and other cultural responses to 21st century issues, presentation, and dissemination. Pre: 3954 with at least a C grade.
Prerequisite(s): C21S 3954
Instructional Contact Hours: (3 Lec, 3 Crd)

C21S 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

C21S 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

C21S 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

C21S 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Aerospace and Ocean Engineering (AOE)

AOE 2024 - Thin-Walled Structures (3 credits)
Basic structural elements of stringer-stiffened thin-walled structures, forces, moments, stresses, and deformation of segmented bars/beams, flexure stress and deflection of beams principal plane, plane of bending and plane of loading for beams with asymmetric cross sections, stresses, and twist due to torsion, shear flow and shear center in open and closed stiffened thin-walled structures, stiffened multicell beams, materials properties and selection.
Prerequisite(s): (ESM 2104 and ESM 2204) or ESM 2114 and (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2054 - Electronics for Aerospace and Ocean Engineers (3 credits)
Electrical circuits. Discrete passive and active electrical components. Phasors and impedence. AC power analysis. Digital electronics. Electronics for autonomous and piloted aerospace and ocean systems. Electronics for vehicle navigation, guidance, and control. Instrumentation and data acquisition systems.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 2074 - Computational Methods (2 credits)
Solving engineering problems using numerical methods and software, truncation and round-off error, root finding, linear and polynomial regression, interpolation, splines, numerical integration, numerical differentiation, solution of linear simultaneous equations. A grade of C- or better is required in the prerequisite.
Prerequisite(s): (ENGE 1216 or ENGE 1434 or ENGE 1414) and (CS 1044 or CS 1064 or CS 1114)
Instructional Contact Hours: (1.5 Lec, 1.5 Lab, 2 Crd)

AOE 2104 - Introduction to Aerospace Engineering and Aircraft Performance (3 credits)
Overview of aerospace engineering from a design perspective; introductory aerodynamics, lift, drag, and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits.
Prerequisite(s): PHYS 2305
Corequisite(s): ESM 2104 or ESM 2114.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2114 - Fundamentals of Flight Training AOE (3 credits)
Foundational course to prepare students with knowledge of basic aeronautics to take the Federal Aviation Administration Knowledge Exam, a requirement for the award of a private pilots license. Explores airplane systems and functions, flight operations, weather, aeronautical navigation, communications, human factors, and federal aviation regulations.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2204 - Introduction to Ocean Engineering (3 credits)
Introduction to the design of ocean vehicles and offshore structures. Buoyancy. Hull geometry, body plan drawing, coefficients of form. Hydrostatic calculations. Intact and damaged stability of ocean vehicles and offshore structures. Large angle stability. Stability criteria for design and related rules and regulations. Marine economics.
Prerequisite(s): PHYS 2305
Corequisite(s): MATH 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2664 - Exploration of the Space Environment (3 credits)
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment, space weather hazards and societal impacts, orbital mechanics and rocket propulsion, spacecraft subsystems, applications of space-based technologies.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 2164

AOE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 3014 - Fluid Dynamics for Aerospace and Ocean Engineers (3 credits)
Fundamentals of fluids: stress, statics, viscosity, laminar and turbulent flow. Conservation of mass and momentum. Vorticity, circulation, and lift. Navier-Stokes equations. Ideal flow in two dimensions, streamlines, stream function, velocity potential, superposition. Thin airfoil theory. Physics of laminar and turbulent boundary layers and of transition. Boundary layer equations and basic tools for boundary layer calculation. Collaborative problem solving.
Prerequisite(s): (AOE 2104 or AOE 2204) and (MATH 2214 or MATH 2214H or MATH 2406H) and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3034 - System Dynamics and Control (3 credits)
Free and forced response of first, second, and higher order linear, time-invariant (LTI) systems in frequency and time domains. Modeling of low-order mechanical systems. Transmission and absorption of vibrations. Transient and steady state performance specifications. Introduction to closed-loop control using proportional-integral-derivative (PID) feedback. Closed-loop stability analysis using root locus method.
Prerequisite(s): ESM 2304 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3044 - Boundary Layer and Heat Transfer (3 credits)
Concepts of viscous flows and physical properties equations of laminar motion with heat and mass transfer; exact and approximate solutions; finite-difference methods; transition to turbulence; analysis in turbulent flows. Conduction and convective heat transfer.
Prerequisite(s): AOE 3014 and (AOE 3164 or AOE 3264 or ME 2134 or ME 3134) and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3054 - Experimental Methods (3 credits)
Fundamental terminology of experimental work and testing in aerospace and ocean engineering. Flow quantities, displacement, and strain measurements of simple structures in both static and dynamic settings. Analog and digital instrumentation. Data acquisition systems and appropriate software. Through teamwork design, prepare, and conduct an experiment, and document its results and findings. Ethics of technical reporting, through proper external source citation and honestly describing procedures and reporting data. Statistical concepts.
Prerequisite(s): AOE 2024 and AOE 2054 and AOE 3014 and AOE 3034
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 3114 - Aerodynamics & Compressibility (3 credits)
Inviscid aerodynamics. Wings and wing theory for low speed flight. How and when compressibility becomes important. Integral form of the conservation equations and thermodynamics. One-dimensional steady compressible flow, nozzle flows. Compressible flow with heat addition. Oblique shock waves and Prandtl-Meyer expansions. Supersonic airfoils. Aerodynamics at subsonic and transonic speeds.
Prerequisite(s): AOE 3014
Corequisite(s): AOE 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3124 - Aerospace Structures (3 credits)
Inertia loads on aerospace structures, introduction to 3D elasticity including strain-displacement relations, stress-strain relations, stress transformation, and equations of equilibrium, plane stress and plane strain elasticity, stress concentration factors, aerospace materials and failure criteria, margins of safety analysis, plate bending, structural stability.
Prerequisite(s): AOE 2024 or AOE 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3134 - Air Vehicle Dynamics (3 credits)
Nonlinear kinematic and dynamic equations of aircraft motion; estimation of stability derivatives from aircraft geometry; determination of steady motions; linearization; longitudinal and lateral-directional small perturbation equations; static and dynamic stability of equilibrium flight.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3144 - Space Vehicle Dynamics (3 credits)
Attitude representations and equations of rotational motion for rigid and multibody spacecraft; attitude determination; linearization and stability analysis of steady motions; effect of the gravity gradient; torque thrusters and momentum exchange devices.
Prerequisite(s): AOE 3034 and AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3154 - Astromechanics (3 credits)
This course teaches the application of Newtons Laws to the dynamics of spaceflight. Topics include the two-body problem equations of motion, Keplers Laws, classical orbital elements, energy and time-of-flight relations, orbit specification and determination, orbital maneuvering and orbit transfers, patched conic approximations, and relative motion.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3164 - Aerothermodynamics and Propulsion Systems (3 credits)
The fundamental principles of aerothermodynamics applied to aerospace propulsion system performance analysis and design. Foundations of thermodynamics, heat transfer, compressible fluid mechanics, and combustion. Applications of principles to air-breathing and rocket engines.
Prerequisite(s): AOE 3014
Corequisite(s): AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3214 - Ocean Wave Mechanics (3 credits)
Introduction to theory of wave in deep and shallow water, including wave generation and propagation. Description of wave statistics and spectral representation for realistic ocean conditions. Introduction to ocean acoustics.
Corequisite(s): 3014, MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3224 - Ocean Structures (3 credits)
Overview of surface ship, submarine and offshore structural systems, materials and loadings. Application of beam and plate bending and buckling theories. Frame structural analysis. Fatigue analysis.
Prerequisite(s): AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3234 - Ocean Vehicle Dynamics (3 credits)
Nonlinear kinematic and dynamic equations of rigid vessel motion in water; hydrostatic and hydrodynamic forces in calm water; motion response to regular and irregular waves; single, multiple and coupled motions degrees of freedom; spectral analysis of response of random seas; statistical analysis of extreme motion response; impact of seakeeping criteria on ocean vehicles design; principles of hydroelasticity; principles of maneuvering of surface and underwater vehicles.
Prerequisite(s): AOE 3014 and AOE 3034 and AOE 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3264 - Thermodynamics and Marine Propulsion (3 credits)
Fundamental thermodynamics and power cycles; marine propulsion plants and transmission systems; methods of estimating resistance of ocean vehicles; propulsion devices and their efficiencies; introduction to propeller theory; cavitation.
Prerequisite(s): AOE 2204 and AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3354 - Avionics Systems (3 credits)
A systems approach to avionics architecture for both civil and military aircraft. Emphasis on system architecture, accepted development processes, sensors, navigation, and certification. Evolution of communications, data models, and sensors required to support autonomous flight as well as the exposures to physical cyber security threats faced by flight management, navigation, and data interchange systems.
Prerequisite(s): AOE 2054 or ECE 2054
Corequisite(s): AOE 3034 or ME 3534 or ME 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3564 - Principles of Project Design and Management (3 credits)
Fundamental principles of model-based project design. Creation of plans for successful development of complex systems such as air, space, and ocean vehicles. Understanding of engineering project performance including emergent scope, cost, and schedule. Systems thinking and systems engineering methods applied to engineering projects as systems: stakeholders, scope, dependence and teamwork dynamics; cost and schedule tradespace; risk assessment and mitigation strategies; and choices in project architecture and organization. Basics of effective teamwork, team building, leadership, and management. Basic understanding of ethical reasoning and conflict management aspects. Oral presentations for design reviews. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3804 - Special Topics in Aircraft Systems (3 credits)
Advanced undergraduate topics in aircraft systems. Covers technical, environmental, and economic challenges and opportunities in contemporary and future aircraft. Function and integration of propulsion, airborne auxiliary power, navigation, flight controls, cargo, landing gear, cabin systems, fuel, and other subsystems. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): AOE 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

AOE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4004 - State-Space Control (3 credits)
Control design and analysis for linear, state-space system models. Properties of linear, time-invariant control systems: Input/output stability, internal stability, controllability, and observability. Performance and robustness measures. State feedback control design methods: pole placement, linear-quadratic control. State observers and output feedback control. Applications to control of mechanical systems including ocean, atmospheric, and space vehicles.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4024 - An Introduction to the Finite Element Method (3 credits)
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied.
Prerequisite(s): (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) or (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4734

AOE 4034 - Introduction to Mechanical and Structural Vibrations (3 credits)
Free and forced vibrations of single-degree-of-freedom systems, multi-degree-of-freedom systems, and continuous systems. Natural frequencies and mode shapes. Proportional and nonproportional damping. Response to harmonic, periodic, and nonperiodic excitations. Boundary-value problem for continuous systems. Eigenvalue problem for rods, beams, and plates. Vibration response of system in modal coordinates. Approximate methods including Assumed Modes, the Rayleigh-Ritz method, and Method of Weighted Residuals.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4054 - Stability of Structures (3 credits)
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion.
Prerequisite(s): AOE 2024 or AOE 3024 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4444

AOE 4064 - Fluid Flows in Nature (3 credits)
Course designed to build upon and broaden a basic traditional engineering knowledge of fluid flows into areas concerning a variety of natural occurrences and phenomena that involve fluid motions in important ways. Drag of sessile systems and motile animals, gliding and soaring, flying and swimming, internal flows in organisms, low Reynolds number flows, fluid-fluid interfaces, unsteady flows in nature and wind engineering.
Prerequisite(s): AOE 3014 or CEE 3304 or ESM 3024 or ME 3404 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4065 - Air Vehicle Design (3 credits)
Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and AOE 3134 and AOE 3164
Corequisite(s): AOE 4105
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4066 - Air Vehicle Design (3 credits)
Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation.
Prerequisite(s): AOE 4065
Corequisite(s): AOE 4106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4084 - Engineering Design Optimization (3 credits)
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4084

AOE 4105 - Experiments for Aerospace Design (1 credit)
Methods for the planning, implementation, assessment and use of experiments in aerospace design problems. 4105: Experiment design, advanced sensor systems, additive manufacturing, uncertainty, data analysis and reporting. 4106: Application of experiments as an integral component of engineering design. Co: 4066 or 4166 for 4106.
Prerequisite(s): AOE 3054
Corequisite(s): 4065 or 4165 for 4105. 4066 or 4166 for 4106.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4106 - Experiments for Aerospace Design (1 credit)
Methods for the planning, implementation, assessment and use of experiments in aerospace design problems. 4105: Experiment design, advanced sensor systems, additive manufacturing, uncertainty, data analysis and reporting. 4106: Application of experiments as an integral component of engineering design. Co: 4066 or 4166 for 4106.
Prerequisite(s): AOE 4105
Corequisite(s): 4065 or 4165 for 4105. 4066 or 4166 for 4106.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4114 - Applied Computational Aerodynamics (3 credits)
Development of computational methods for application to wing aerodynamic problems. Incompressible airfoil codes. Panel methods and vortex lattice methods. Finite difference techniques. Transonic and supersonic applications.
Prerequisite(s): AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4124 - Configuration Aerodynamics (3 credits)
Aerodynamic design of flight vehicles, with emphasis on nonlinear flowfields and configuration concepts. Aerodynamic analysis and design for transonic, supersonic, hypersonic flows, and low speed high alpha flight. Includes case studies of classic configurations and aerodynamic design papers.
Prerequisite(s): AOE 3014 and AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4140 - Spacecraft Dynamics and Control (3 credits)
Space missions and the way pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modeling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational maneuvers. Environmental torques. Impacts of attitude stabilization techniques on mission performance.
Prerequisite(s): AOE 3034 and (AOE 4134 or AOE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4165 - Space Vehicle Design (3 credits)
Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and AOE 3144 and AOE 3154 and AOE 3164
Corequisite(s): AOE 4105
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4166 - Space Vehicle Design (3 credits)
Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation.
Prerequisite(s): AOE 4165
Corequisite(s): AOE 4106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4174 - Spacecraft Propulsion (3 credits)
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues.
Prerequisite(s): AOE 3164 or AOE 4234 or ME 4234
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4174

AOE 4205 - Experiments for Ocean Vehicle Design (1 credit)
4205: Facilities, instrumentation, and experiments pertinent to ocean engineering in the field of flow measurements and resistance and propulsion tests of surface and underwater vehicles. Analysis and communication of experimental data through technical report writing. 4206: Assessment of ocean system design through experiments, data analysis, and technical report writing.
Prerequisite(s): AOE 3054
Corequisite(s): AOE 4265
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4206 - Experiments for Ocean Vehicle Design (1 credit)
4205: Facilities, instrumentation, and experiments pertinent to ocean engineering in the field of flow measurements and resistance and propulsion tests of surface and underwater vehicles. Analysis and communication of experimental data through technical report writing. 4206: Assessment of ocean system design through experiments, data analysis, and technical report writing.
Prerequisite(s): AOE 3054
Corequisite(s): AOE 4266
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4224 - Atmospheric and Ocean Vehicle Model Identification (3 credits)
Atmospheric and ocean vehicle dynamic modeling from experimental data including: experiment design; model structure determination; parameter and state estimation; and data analysis methods. Regression and maximum likelihood approaches. Time and frequency domain formulations. Applications to airplanes, rotorcraft, surface vessels, and undersea vehicles.
Prerequisite(s): AOE 3134 or AOE 3234
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4234 - Aerospace Propulsion Systems (3 credits)
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements.
Prerequisite(s): AOE 3114 and (AOE 3164 or AOE 3264) or ME 3414 and ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4234

AOE 4244 - Naval and Marine Engineering Systems Design (3 credits)
Concepts, theory and methods for the design, integration, and assessment of naval and marine engineering systems considering energy conservation, ship arrangements, system deactivation diagrams, reliability, maintenance, system power, shock and weapons effects, machinery sizing, and system vulnerability. Physics-based mechanical, electrical, thermal, sensor, control, weapon systems, hullform and engine (diesel and gas turbine) models are used to predict total system performance. Linear programming methods and flow-based models are used to optimize systems architecture and size components.
Prerequisite(s): AOE 3264
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4264 - Principles of Naval Engineering (3 credits)
This course studies naval engineering systems and systems engineering processes with particular emphasis on: naval missions; combat system performance including radar; underwater acoustics and sonar; ballistics; weapon propulsion and architecture; weapons effects; ship survivability including underwater explosion and shock waves; surface ship and submarine balance and feasibility analysis; and total ship integration. Senior Standing required.
Prerequisite(s): (MATH 2224 or MATH 2204 or MATH 2204H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4265 - Ocean Vehicle Design (3 credits)
Study and application of systems engineering process and ocean engineering principles to the concept exploration, design and development of ocean vehicles including ships, submarines, surface and subsurface autonomous vehicles, boats and yachts. 4265: Emphasis on hullform, power and propulsion, synthesis, balance, metrics and design optimization. 4266: Emphasis on topside/external arrangements, internal arrangements, machinery arrangements, human systems, structural design, and final assessments of intact and damage stability, weights, space, seakeeping, cost, risk, overall balance and feasibility. Most of the work is done in teams.
Prerequisite(s): AOE 2204 and AOE 3214 and AOE 3224 and AOE 3234 and AOE 3264
Corequisite(s): AOE 4205
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4266 - Ocean Vehicle Design (3 credits)
Study and application of systems engineering process and ocean engineering principles to the concept exploration, design and development of ocean vehicles including ships, submarines, surface and subsurface autonomous vehicles, boats and yachts. 4265: Emphasis on hullform, power and propulsion, synthesis, balance, metrics and design optimization. 4266: Emphasis on topside/external arrangements, internal arrangements, machinery arrangements, human systems, structural design, and final assessments of intact and damage stability, weights, space, seakeeping, cost, risk, overall balance and feasibility. Most of the work is done in teams.
Prerequisite(s): AOE 4265
Corequisite(s): AOE 4206
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4274 - Intermediate Ship Structural Analysis (3 credits)
Analysis of plate bending, buckling, and ultimate strength using computational tools and methods. Calculation of elastic buckling of stiffened panels. Eigenvalue methods for buckling and vibration. Incremental plastic collapse; other progressive collapse. Ultimate strength of large structural modules due to combined loads. Introductory level finite element analysis.
Prerequisite(s): AOE 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4324 - Energy Methods for Structures (3 credits)
Work and energy relationships in structures, flexibility and stiffness influence coefficients, Maxwell and Betti-Rayleigh reciprocal theorems, strain energy and complementary strain energy for thin-walled structures, Castigliano's first and second theorems for trusses and frames, unit action and unit displacement states, direct stiffness method, principles of minimum total potential energy and total complementary energy for bars, beams, and plates, Ritz method, finite element method for bars and beams.
Prerequisite(s): AOE 2024 and (AOE 3124 or AOE 3224)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4334 - Ship Dynamics (3 credits)
Analysis of motions of rigid body vehicles in water, including influence of added mass and buoyancy. Seakeeping motion responses in waves, wave-induced structural loads, random response analysis via spectral analysis, and extreme response analysis. Introduction to hydroelasticity and maneuvering.
Prerequisite(s): AOE 3014 and AOE 3034 and (AOE 3214 or AOE 4214) and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4344 - Dynamics of High-Speed Marine Craft (3 credits)
Introduction to the dynamics of high-speed craft, including surface effect ships, hydrofoil vessels, semi-displacement monohulls and catamarans, and planing vessels.
Prerequisite(s): AOE 3264
Corequisite(s): 4334 or 3234.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4365 - Launch Vehicle Design (3 credits)
Fundamental principles of innovative launch vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary (e.g., propulsion, structures, orbital mechanics, economics, or aerodynamics) design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4365: Proven conceptual design process. Tradeoff studies. Launch vehicle weight estimation. Launch vehicle concepts feasibility assessment; 4366: Preliminary design tools and processes. Efficient and light-weight launch vehicles. Launch vehicle design validation. Launch vehicle operation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and (AOE 3134 or AOE 3144) and AOE 3164
Corequisite(s): AOE 4105
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4366 - Launch Vehicle Design (3 credits)
Fundamental principles of innovative launch vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary (e.g., propulsion, structures, orbital mechanics, economics, or aerodynamics) design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4365: Proven conceptual design process. Tradeoff studies. Launch vehicle weight estimation. Launch vehicle concepts feasibility assessment; 4366: Preliminary design tools and processes. Efficient and light-weight launch vehicles. Launch vehicle design validation. Launch vehicle operation.
Prerequisite(s): AOE 4365
Corequisite(s): AOE 4106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4404 - Applied Numerical Methods (3 credits)
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and MATH 4404.
Prerequisite(s): MATH 4564 and (ESM 2074 or AOE 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MATH 4404

AOE 4414 - Computer Aided Space Mission Analysis (3 credits)
Advanced space mission design, requirements development, and analysis. Analyses of current and future space systems and missions, space platform and payload concepts. Orbital mechanics; coverage; space-to-ground and space-to-space communications; remote sensing; disaggregation; infrastructure; terrain modeling; space vehicle and payload performance constraints, dynamics, and degradation; homogeneous and heterogeneous constellations; launch; the space environment; space mission environmental and economic impact; and mission modeling and simulation for Earth orbit, interplanetary, and CisLunar regimes.
Prerequisite(s): (AOE 2074 or ESM 2074 or ECE 2504) and (AOE 2664 or ECE 2164 or AOE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4434 - Introduction to Computational Fluid Dynamics (3 credits)
Euler and Navier-Stokes equations governing the flow of gases and liquids. Mathematical character of partial differential equations. Discretization approaches with a focus on the finite difference method. Explicit and implicit solution techniques and their numerical stability. Introduction to verification, validation, and uncertainty quantification for computational fluid dynamics predictions.
Prerequisite(s): MATH 2214
Corequisite(s): AOE 3044 or ME 3404 or ESM 3016.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4454 - Spacecraft Position/Navigation/Timing and Orbit Determination (3 credits)
Position/Navigation/Timing (PNT) measurements and optimal batch filter estimation methods for spacecraft with emphasis on orbit determination; GPS position/velocity/time point solutions; linearized state transition matrices; batch least-squares filter Orbit Determination (OD) solutions from a time series of observations; precision and accuracy assessment using covariance and overlap statistics; one-way and two-way radio range and range-rate observations; optical bearings observations; non-Keplerian orbital effects.
Prerequisite(s): AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4464 - Introduction to Global Positioning System (GPS) Theory and Design (4 credits)
Fundamental theory and applications of radio navigation with the Global Positioning System GPS. Satellite orbit theory, GPS signal structure and theory, point positioning with pseudoranges and carrier phases, selective availability, dilution of precision, differential GPS, atmospheric effects on GPS signals.
Prerequisite(s): ECE 3105 or AOE 4134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ECE 4164

AOE 4474 - Propellers and Turbines (3 credits)
Theory, numerical methods, and experimental techniques for analysis and design of propellers and turbines. Geometry description and creation of computer models. Analysis of inflow from wakes and atmospheric boundary layers. Performance characteristics including open-water and multi-quadrant operation, scale effects, and standard series data. Theoretical analysis and selection of airfoil and hydrofoil sections. Theory and numerical methods for propellers and turbines, including computational fluid dynamics (CFD) simulation. Design of wake-adapted propellers. Design of wind-turbine rotors in steady wind. Structural analysis of propeller and turbine blades. Wind- and water-tunnel testing for thrust and torque.
Prerequisite(s): AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4514 - Nonlinear Dynamics and Chaos (3 credits)
Motion of systems governed by differential equations: stability, geometry, phase planes, bifurcations, Poincare sections, point attractors, limit cycles, chaos and strange attractors, Lyapunov exponents. Forced, nonlinear oscillations: jump phenomena, harmonic resonances, Hopf bifurcations, averaging and multiple-scales analysis. Systems governed by discrete maps: return maps, cobweb plots, period-multiplying bifurcations, intermittency, delay coordinates, fractal dimensions.
Prerequisite(s): (ESM 2304 or PHYS 2504) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4114

AOE 4604 - Booster Design, Fabrication, and Operation (3 credits)
Theory, design, operations, and fabrication methodologies employed to manufacture boosters. The rocket equation, solid, liquid, and hybrid propellant systems, combustion chamber design, vehicle structures, telemetry, guidance and navigation, launch operations, and failure modalities.
Prerequisite(s): AOE 2074 and AOE 3124 and AOE 3154 and AOE 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4614 - Aerospace Materials and Modeling Techniques (3 credits)
Aircraft, spacecraft structural and engine materials. Mechanical, thermal properties and chemical stability of metallic materials. Aluminum, iron, nickel and titanium -based alloys. Atomistic structure, elastic properties, elastic anisotropy and microscopic origins. Plasticity, dislocations, and strengthening mechanism. Liquid-solid and solid-state phase transformation in alloys. Facture, creep and fatigue. Oxidation and corrosion. Simulating materials behaviors using molecular dynamics techniques.
Prerequisite(s): CHEM 1035 and PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4624 - Foundations of Aero and Hydroacoustics (3 credits)
Fundamental background to the field of aero/hydroacoustics. Quantifying sound levels, acoustic intensity, the acoustic wave equation, and linear acoustics. Fluid dynamics, turbulence, and thermodynamics in aeroacoustics. Lighthill's equation, and Curle's equation. Characterization and identification of aeroacoustic sources. Leading and trailing edge noise. Basics of aeroacoustic wind tunnel testing.
Prerequisite(s): AOE 3014 and AOE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4634 - Wind Turbine Technology and Aerodynamics (3 credits)
Aerodynamics and elastic behavior of a modern wind turbine. Internal and aerodynamic loads of wind turbines. Locating wind turbines with respect to fatigue, annual power and noise productions. Aeroelastic behavior of wind turbine blades. Generators, transformers and power converters used in wind energy. Historical, economic, political, and innovation issues related to wind energy and power grid integration.
Prerequisite(s): AOE 3014 and (AOE 3124 or AOE 3224)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4654 - Space Weather: The Solar Wind and Magnetosphere (3 credits)
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earths magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation.
Prerequisite(s): ECE 3105 or AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4154

AOE 4674 - Upper Atmosphere/Ionosphere Space Weather (3 credits)
Interaction of Earth's upper atmosphere and space environment with spacecraft: processes that affect atmospheric density relevant to spacecraft orbit decay; basic composition and structure; radiation and radiative transfer; atmospheric energy balance; atmospheric chemistry and ion production/loss mechanisms; fundamental concepts of Solar-terrestrial physics including ionospheric Chapman theory; atmospheric energy/mass transport; ionospheric electrodynamics; ionospheric storms; planetary atmospheres/ionospheres; instrumentation.
Prerequisite(s): AOE 3014 or ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4174

AOE 4804 - Special Topics in Dynamics, Control, and Estimation (3 credits)
Advanced undergraduate topics in dynamics, control, and estimation related to a particular class of aerospace and ocean engineering systems. Sample course topics include navigation and guidance, aircraft flight control, and ocean vessel motion control. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): AOE 4004
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

AOE 4814 - Special Topics in Propulsion (3 credits)
Advanced undergraduate topics in propulsion for aerospace and ocean vehicles. Covers technical, environmental, and economic challenges and opportunities in contemporary and future propulsion concepts. Comparative analyses of conventional and advanced propulsion systems and propulsion/vehicle integration concepts based upon first principles. Topics include distributed propulsion, green propulsion and propulsion/airframe integration. May be repeated with different content for a maximum of 6 credits.
Prerequisite(s): AOE 3164 or AOE 3264
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

AOE 4824 - Special Topics in Energy and the Environment (3 credits)
Advanced undergraduate topics in energy and the environment related to aerospace and ocean engineering systems. Sample course topics include renewable energy and energy management.
Prerequisite(s): AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4864 - Special Topics in Space Engineering (3 credits)
Advanced undergraduate topics in space engineering. Covers technical, environmental, and economic challenges and opportunities in contemporary and future space systems and space missions. Comparative analyses of current and future space systems and missions, and space platform and payload concepts. Topics may include remote sensing, disaggregation, infrastructure, and mission modeling and simulation. May be repeated with different content for a maximum of 6 credits.
Prerequisite(s): AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

AOE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Agr, Leadership, & Comm. Ed. (ALCE)

ALCE 2094 - Introduction to Metal Fabrication (1 credit)
Introduction to metal working tools, equipment/operation and safety practices. Including the fundamentals of Oxy-Acetylene (OA) gas welding, Shielded Metal Arc Welding (SMAW) and Gas Metal Arc Welding (GMAW).
Instructional Contact Hours: (3 Lab, 1 Crd)

ALCE 2294 - Animal Structures and Environment (3 credits)
Functional considerations in facilities development for production agriculture. Concepts of farmstead planning and system development. Techniques for providing safe and efficient animal production environments, especially for confinement facilities.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 2414 - Identity and Inclusion in Agricultural and Life Sciences (3 credits)
Examines histories of persons representing different social identities, statuses, space, place, and traditions in agricultural and life sciences. Explores how differences influence experiences individuals may have in agricultural and life sciences. Apply ethical reasoning practices to recognize and addresses critical issues surrounding inclusion of diverse populations within agricultural and life sciences education and leadership.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2414

ALCE 2484 - Engine and Power Train Technology (3 credits)
Engine and power train technology with an emphasis on the fundamentals of internal combustion engines, electrical systems, power transmission systems and maintenance practices.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALCE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 3004 - Educational Programs in Agricultural and Life Sciences (3 credits)
Offers a foundation for student engagement and exploration of educational programs within agricultural and life sciences. Formal and non-formal learning contexts in local community programs. Opportunities include fieldwork assignments.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3014 - Leadership Effectiveness for Professionals in Agricultural Organizations (3 credits)
Leadership theory and skills required to perform effectively in leadership positions within agricultural organizations and communities. Leadership skills, personal development, teamwork, and social responsibility in agriculture industry.
Prerequisite(s): LDRS 1015 or LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3084 - Agricultural Metal Fabrication (3 credits)
Introduction to metal working tools, equipment, and processes. Fundamentals of hot and cold metal working, plumbing, and welding applications, including inert gas welding processes. Junior standing or consent of instructor is required.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ALCE 3494 - Advanced Welding Technology (1 credit)
Techniques in metal work and welding that include tool maintenance, Oxy-Acetylene (OA), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW). Design of welded structures, fundamentals of heat treatment, plastic welding and Plasma Arc Cutting (PAC). Pre: Junior standing.
Instructional Contact Hours: (3 Lab, 1 Crd)

ALCE 3624 - Communicating Ag and Life Sciences in Writing (3 credits)
Communication skills necessary to carry out work with the general public and audiences in the food, agriculture, and natural resources fields. Professional writing for diverse audiences, assessing best written communication practices, and on creation of a portfolio, utilizing multiple platforms of written communication. Pre: Junior standing.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3634 - Communicating Ag and Life Sciences in Speaking (3 credits)
Strategies and techniques for effective oral communication in professions related to food, agriculture, and natural resources. Oral, visual, and interpersonal communication, ethical framing of complex problems, group leadership, and meeting management.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3814 - Life Sciences Communication & Public Engagement (3 credits)
Identifying principles of inclusive and culturally responsive public engagement. Creating life sciences communication strategies and community-centered approaches that maximize public engagement. Evaluating effects of life sciences communication strategies on public engagement.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ALCE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4004 - Teaching Adults in Agriculture (2 credits)
Organizing classes, developing programs of instruction and teaching techniques applicable to out-of-school groups in Agriculture.
Instructional Contact Hours: (2 Lec, 2 Crd)

ALCE 4014 - Introduction to Cooperative Extension (3 credits)
An overview of the Cooperative Extension Service as it applies to non-formal education for citizens and communities. Major areas discussed include history, organization, functional areas, responsibilities of local agents, employment in extension, and educational program planning.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4024 - Managing Agricultural Supervised Occupational Experience Project (2 credits)
Major emphasis will be given to the agricultural teachers responsibility for supervision of the Supervised Occupational Experience Program (SOEP). The course will emphasize the ownership project, the cooperative placement project, maintaining record books, and supervising the SOEP.
Instructional Contact Hours: (2 Lec, 2 Crd)

ALCE 4034 - Methods of Planning Education Programs for Agriculture (3 credits)
Course examines the procedures involved in the development of courses, curriculum, and instructional materials for education programs in agriculture.
Prerequisite(s): ALCE 3004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: EDCT 4034

ALCE 4044 - Agricultural Sciences Seminar (3 credits)
A senior capstone course addressing issues of importance for majors in Agricultural Sciences. The course will emphasize a synthesis of research results from collected data and information on contemporary problems in agriculture and related fields and a sharing of the results. It will emphasize the development of skills in critical analysis. Senior Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4054 - Internship in Coop Extension (1-16 credits)
Off-campus participation experience for those preparing to become extension agents in the Cooperative Extension Service. Variable Credit; 6-16 credits.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)

ALCE 4064 - Ag Mechanical Lab Management (3 credits)
Plan, organize, and manage secondary school mechanics laboratories. Management of the instructional program, facility, equipment, inventory, safety, liability, personnel, material control, and student customer work.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALCE 4234 - Curriculum for Career and Occupational Education (3 credits)
Provides current and prospective career and occupational education teachers with research bases, resources, and available curricula for teaching content in the respective disciplines. Develops the ability to plan, manage, develop, and evaluate curricula. The prerequisite EDCT 2604 will be waived for Agricultural Education students. Pre: Junior Standing
Prerequisite(s): EDCT 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4244 - Teaching and Training Methods in Agricultural and Life Sciences (3 credits)
Survey of strategies for design, implementation, and evaluation of instruction and training practices in agricultural life sciences. Applications of principles in formal and non-formal educational settings, including schools, extension, and industry. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4254 - Adult Vocational&Technical Ed (3 credits)
Theory, practices, and procedures involved in planning, developing, implementing, managing, and evaluating adult education programs in Vocational and Technical Education. Completion of, or concurrent enrollment in, courses in teaching methods and curriculum required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4304 - Community Education and Development (3 credits)
Comprehensive examination of community education and development. Community/sustainable community development, strategies for mobilizing social change in/with communities. Explore participatory, popular, and community-based education from rural and urban settings. Globalization, sustainability, and social movement discourse with emphasis on agricultural, health, and food system examples. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4744 - Methods, Materials and Practices in Instruction (1-6 credits)
Planning, using, evaluating classroom procedures; selection and organization of subject content and materials in vocational and technical education. Maximum credit: 6 Consent required.
Corequisite(s): EDCT 4754
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ALCE 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)

ALCE 4884 - Youth Program Management (3 credits)
Organizational design of educational youth programs such as 4-H and FFA, including administrative planning, human resource development, recruitment, marketing, and budgeting.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCT 4884

ALCE 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Agricultural and Applied Econo (AAEC)

AAEC 1005 - Economics of the Food and Fiber System (3 credits)
1005: How the individual economic actor makes rational choices as: consumer, producer, firm/farm, saver, investor, employee, employer, manager, trader. Economic principles that underlie exchange in business, government and household transactions. Utility maximization in the U.S. and global food and fiber system under conditions of scarcity. Evaluation of policy issues important to society. 1006: Overview of economic systems: capitalism versus communism, socialism, feudalism, mercantilism. Interrelationships of U.S. economic fiscal and monetary institutions and policies regarding agricultural productivity, business vitality, sustainable development, and human capital formation. Affordability, safety and security of food and fiber, cultural dynamics, consumer welfare, industrial profitability, natural resources conservation, rural economic infrastructure, international trade, and social justice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 1006 - Economics of the Food and Fiber System (3 credits)
1005: How the individual economic actor makes rational choices as: consumer, producer, firm/farm, saver, investor, employee, employer, manager, trader. Economic principles that underlie exchange in business, government and household transactions. Utility maximization in the U.S. and global food and fiber system under conditions of scarcity. Evaluation of policy issues important to society. 1006: Overview of economic systems: capitalism versus communism, socialism, feudalism, mercantilism. Interrelationships of U.S. economic fiscal and monetary institutions and policies regarding agricultural productivity, business vitality, sustainable development, and human capital formation. Affordability, safety and security of food and fiber, cultural dynamics, consumer welfare, industrial profitability, natural resources conservation, rural economic infrastructure, international trade, and social justice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2104 - Personal Financial Planning (3 credits)
Survey of fundamental personal financial planning needs and decisions of young professionals. Introduction to the personal financial planning needs that special household circumstances or non-traditional household situations may precipitate. Application of cash, credit, and debt management principles to household scenarios. Completion of federal income tax forms for individuals. Managing the household's risk exposure. Introduction to investment decisions, particularly related to retirement accounts. Overview of basic estate planning tools and principles. Discussion of the ethical issues related to financial products and decisions.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2434 - Foundations of Agribusiness (3 credits)
Introduction to the primary management tools as they relate to farm production enterprises and agribusinesses. Principles and concepts of preparing farm and agribusiness financial statements and their analysis. Application of budgeting and risk management.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3004 - Agricultural Production and Consumption Economics (3 credits)
The economic principles of production. Applications to decision-making and the allocation of resources for the agricultural firm. Consumer behavior and demand for agricultural products.
Prerequisite(s): (AAEC 1005 or ECON 2005) and (MATH 1025 or MATH 1225)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3014 - Analytical Methods in Applied Economics (3 credits)
Quantitative methods used in applied empirical economic analysis including simple and multiple regression, estimation and application of elasticity, decision analysis, economic simulations, linear programming, and risk analysis. Analysis using spreadsheets stressed.
Prerequisite(s): STAT 3005 or BIT 2405 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3015 - Internship in Agricultural and Applied Economics (1 credit)
Preparation for, and follow-up to, a practical experience in a selected agricultural, resource, or governmental enterprise, which takes place under the direct supervision of an owner, manager, or supervisor. 3015: offers the student a broad management horizon on understanding the value and the process of setting goals and objectives, and provides methods for evaluating ones abilities, interests, and desires for making career-path choices. 3016: provides a forum for students to share work experiences, discuss human resource issues, and apply the problem solving process to a problem or concern witnessed during the internship.
Instructional Contact Hours: (1 Lec, 1 Crd)

AAEC 3024 - Monetary and Global Issues in Applied Economics (3 credits)
Economics of an open economy and its impact on agricultural and natural resource markets. History of the monetary system, national accounts, balance of payments, fiscal and monetary policy, foreign exchange determinants, trade deficits, international finance, globalization and economic growth. Linkages to agricultural policy and commodity markets stressed.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3204 - International Agricultural Development and Trade (3 credits)
Examination of the role of agriculture in less developed countries and how that role is affected by public policies. Dimensions of world food, population, and income problems; theories of economic development and the role of agriculture; traditional agricultural systems and their evolution; agricultural modernization strategies; interactions among natural resources, biofuels, food prices, and sustainable agriculture; the impacts of international trade and aid; and the effects of international development on U.S. agriculture.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3314 - Environmental Law (3 credits)
Principles of law involved in environmental issues, survey of environmental litigation, legislation and administrative rulings. Law topics include natural resources, water pollution, private land use, air pollution, toxic substance, food, drug, pesticides, and biotechnology.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3324 - Environment and Sustainable Development Economics (3 credits)
Sustainable development through an exploration of hard and soft green schools of thought. Hard Green Strategies – reliance on markets, technology, property rights, human ingenuity to increase production efficiency versus Soft Green Strategies-adoption of simpler lifestyles, government subsidies, natural design of buildings (biomimicry), and urban infrastructure to locate public transportation hubs nearest to densely populated neighborhoods to decrease consumption of natural resources. Connecting the influence of place in personal and group identity. Interdisciplinary examination of environmental justice among poor and minority U.S. communities. Social equity distribution of the economic costs and benefits of natural resources management policies. Roles of property rights, economic incentives, religious values, and political power in determining local communities' capacity to control their environmental destiny.
Prerequisite(s): AAEC 1005 or AAEC 1006 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3424 - Value-Based Management in Agribusiness (3 credits)
Focus on finance concepts in the agricultural and environmental sectors. Apply the value-based management principles and financial analysis to industry-related cases. Estimate cost of capital, free cash flow and net present value. Team-based approach on a real-world valuation case.
Prerequisite(s): AAEC 1005 and AAEC 1006 and ACIS 2115
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3454 - Small Business Management and Entrepreneurship (3 credits)
Characteristics of small business and entrepreneurs, and their economic importance. Development and operation of a small business, including concepts and principles such as franchising, business plans, capital acquisition, venture capital, financial and administrative control, marketing, human resource and operations management. Taxation, legal, insurance and ethics in small business.
Prerequisite(s): AAEC 2434 or ACIS 2115 or MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3504 - Marketing Agricultural Products (3 credits)
Structure of the agricultural marketing system with emphasis on factors determining farm level prices. Emphasis on how markets coordinate consumer desires and producer costs through marketing channels. Impact of market structure, grades, information, product form, and advertising on farm prices. International trade impacts on producers, consumers, agribusiness, and government.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3514 - Agricultural Futures and Options (3 credits)
The role of agricultural futures and options in risk management strategies for producers and agribusiness firms and in the price discovery process. Fundamental supply-demand and technical analysis of the markets and pricing processes. Development and applications of effective price risk management strategies.
Prerequisite(s): AAEC 1005 and AAEC 1006 and AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3604 - Agricultural Law (3 credits)
Legal problems of farm and agribusiness management. Practical application of principles of contracts, negligence, debt instruments and commercial transactions of the farm and agribusiness organization. Selected state and federal laws regulating the farm and agribusiness sector; basic animal laws including state and federal regulation of agricultural sector.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

AAEC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4135 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4135

AAEC 4136 - International Economics (3 credits)
4135: International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136: International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4136

AAEC 4204 - Food and Agricultural Policy (3 credits)
Examination of the role of agriculture in developed economies and how agriculture is affected by policy decisions in the public sector. Emphasis will be placed on the economic impacts of policies on the producers and consumers of agricultural products: price supports, food stamps, tariffs and quotas.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4314 - Environmental Economic Analysis and Management (3 credits)
Quantitative methods and computer-aided tools used in the economic analysis of environmental/natural resource issues. Economic concepts and analytical tools will be applied to realistic, problem-solving situations. Topics include cost effectiveness analysis, benefit-cost analysis, economic simulations, and statistical analysis.
Prerequisite(s): AAEC 3324 or ECON 4014 or FREC 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4324 - Rural and Regional Development Policy (3 credits)
Description of rural areas, their economic structure, and conditions for broad-based economic development. Emphasis on the role of markets in the development process. Introduction to tools to evaluate policies and programs, identify distributional impacts, identify appropriateness for long-term sustainable development, and analyze tradeoffs between policy goals. Alternatives to public financing in rural areas.
Prerequisite(s): AAEC 1005 and AAEC 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4334 - Applications Rural Development (1 credit)
Evaluation of policy alternatives and programs for the development of rural areas. Intensive use of analytical techniques, including spreadsheet analysis of trends and changes over time, shift-share analysis of economic change, creation of indices of distribution and poverty for rural areas, creation and use of economic base multipliers, construction, use and interpretation of input-output models.
Prerequisite(s): AAEC 1005 and AAEC 3004
Corequisite(s): AAEC 4324
Instructional Contact Hours: (1 Lec, 1 Crd)

AAEC 4344 - Sustainable Development Economics (3 credits)
Sustainable development concepts are critically explored particular emphasis on implications for domestic and international sustainable development agriculture and for economic development. Students investigate case studies illustrating problems of sustainable development and potential policy solutions.
Prerequisite(s): AAEC 3324 or AAEC 3004 or ECON 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4354 - Energy Economics (3 credits)
Theoretical and quantitative economic analyses of individual, regional, and global demand and supply of renewable and nonrenewable energy. Markets examined include solar, wind, oil, natural gas, electricity, and nuclear. Policies reviewed include those used to regulate energy prices, tax carbon emissions, and promote technology adoption. Countries studied include the U.S., Europe, and Asia, encompassing both developed and developing nations. Pre: Junior Standing.
Prerequisite(s): AAEC 1005 or AAEC 1006 or ECON 2005 or ECON 2006 or MATH 1025 or MATH 1225
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4404 - Agricultural Management and Problem-solving (3 credits)
Capstone course for students interested in agribusiness management. Application of concepts, tools, and principles including management, finance, marketing, economic theory, and quantitative methods to applied agricultural decisions. Application of knowledge on selected agricultural projects that enhance team-building, written, and oral communication skills. Senior Standing required.
Prerequisite(s): AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4414 - Applied Economic Problem-Solving (3 credits)
Application of economic training and skillsets to real-world needs identified by clientele. Team problem-solving of financial, marketing, production, legal and regulatory, and human resources issues unique to the agriculture sector. Facilitated experiential learning environment focused on student-motivated solutions to economic risk management. This course may be repeated once.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4424 - Ag Financial Management (3 credits)
Principles and concepts of preparing agricultural financial statements. Analysis of these statements following professional farm financial guidelines. Economic concepts applied to management of agricultural enterprises. Leasing, purchasing, borrowing, and lending decisions in agriculture. Agricultural applications of budget, risk management and mitigation, and loan structuring.
Prerequisite(s): AAEC 1005 and AAEC 2434 and (FIN 3104 or AAEC 3424)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4434 - Commodity Investing by Students (2 credits)
Students make real world investment decisions in agricultural and energy commodities, execute trades, evaluate their performance and report to the VT Foundation. This student-run organization provides leadership opportunities as well as collaboration and networking experiences. Restricted to COINS members. May be repeated with different content up to 8 credit hours. This course is Pass/Fail.
Prerequisite(s): AAEC 4504
Instructional Contact Hours: (2 Lec, 2 Crd)
Repeatability: up to 8 credit hours

AAEC 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4464, WATR 4464

AAEC 4484 - Applied Economic Forecasting (3 credits)
Forecasting economic, agricultural and environmental data using basic linear and non-linear time series models. Programming and computational implementation of time series forecasting model selection techniques and practical applications.
Prerequisite(s): (AAEC 1005 or AAEC 1006) and (STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4504 - Agricultural Price and Market Analysis (3 credits)
Estimation of agricultural supply, demand, and price relationships. Determination of market potential for new products. Students identify problem, collect data, estimate statistical relationship(s), interpret results, and write research report. Use of probability distribution in marketing strategy development.
Prerequisite(s): AAEC 3004 and STAT 3005 or STAT 3615 or BIT 2405
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4514 - Advanced Agribusiness Marketing (1-4 credits)
Applying concepts, principles, and analytical tools in developing a marketing plan for an existing or new agricultural product or service. Students will define the market, perform competitive marketing analysis, outline market assumptions and objectives, and perform a three-year financial evaluation of the action plan. Course can be repeated once.
Prerequisite(s): AAEC 2434 and AAEC 3504
Corequisite(s): 3504 or 3004.
Instructional Contact Hours: (1-4 Lec, 1-4 Crd)
Repeatability: up to 4 credit hours

AAEC 4804 - Elementary Econometrics (3 credits)
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations.
Prerequisite(s): AAEC 1005 and (STAT 3615 or STAT 3005 or STAT 3604 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4804

AAEC 4814 - Food and Health Economics (3 credits)
Microeconomics of food, nutrition, and health. Overview of nutrition, nutrition recommendations, and implications for economics based decisions. Individual and household food consumption and health production models. Farm to consumer market linkage models with nutrition and health implications Effectiveness of food and nutrition interventions and policies. Cost-benefit and cost-effectiveness analysis of health interventions. Pre: Senior Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Agriculture and Life Sciences (ALS)

ALS 1004 - Agriculture, the Arts and Society (1 credit)
Interpretive strategies applied to agriculture and the visual arts. Artistic representations of agriculture, farming, rural livelihoods, and agrarian landscapes. Exploration of global agricultural challenges balancing the production of food, fiber, and fuel. Apply principles of design and art using photography medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1014 - Gardens as Art (1 credit)
Interpretive strategies applied to agriculture and gardening design. Artistic representations of agriculture and landscaping. Exploration of global agricultural challenges balancing the production of food, gentrification, and location. Application of principles design and elements of visual art using gardening medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1024 - Digitized Agriculture (1 credit)
Interpretive strategies applied to agricultural art and design. Artistic representations of agriculture and nature. Agriculture through digital art (narrative art, stories, and data visualization). Exploration of global agricultural challenges balancing the production of food, fiber, fuel- and location. Elements, methods of interpreting, and principles and application of art and design using a narrative medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1034 - The Aesthetics of Food (1 credit)
Food as a method of study for art and design. Taste, smell, color, shape, presentation, memory, and packaging of food related to human cultural experience. Food presentation, marketing, and food choices in global context influence how people experience food.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1234 - CALS First Year Seminar (1 credit)
Exploration of topics related to the College of Agriculture and Life Sciences (CALS) from a multidisciplinary perspective with a focus on communication and teamwork, problem-solving, inquiry, and integration. Students explore resources to promote academic success, investigate careers and academic areas, and develop a comprehensive plan of study. Freshman and transfer students only.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 1984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

ALS 2204 - Sustainable Food Systems (3 credits)
Introduction to the economic, social, and ecological foundations of civic agriculture. Topics include industrialization, localized food systems, and citizen participation in civic agriculture. Emphasis will be given to a range of civic agriculture models, strategies, and hands-on approaches to establish, retain and strengthen community-based food and agriculture systems, locally- nationally-globally.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2304 - Comparative Animal Physiology and Anatomy (4 credits)
Comparative anatomy and physiology of domestic mammals and birds including cell neural, musculoskeletal, respiratory, cardiovascular, urinary, and endocrine systems.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

ALS 2404 - Biotechnology in A Global Society (3 credits)
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening.
Prerequisite(s): (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H) and (CHEM 1015 and CHEM 1016)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 2404

ALS 2504 - Animals in Society (3 credits)
Animal well-being and behavior, human-animal interactions, ethical responsibilities to animals, animal care, behavior, disease, and pain recognition. Current topics concerning companion animals, domestic animals, and wildlife.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2604 - Intro to Interdisciplinary Research Practices (3 credits)
Introduction to formal undergraduate research and basic research methods. Engagement in interdisciplinary collaboration via team research projects. Exploration of scholarly literature, topic development, information evaluation, citation and data management, research ethics, and scientific communication. Connections to advanced information and digital literacy topics such as research impact and digital repositories. Formal proposal development and presentation.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

ALS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 3104 - Animal Breeding and Genetics (3 credits)
Principles of genetics applied to improvement of domestic animals: factors affecting genetic improvement of economically relevant traits, estimation of breeding values, heritability, genetic correlations, relationships, inbreeding, crossbreeding, genetic abnormalities, genomic selection, and gene editing; ethical reasoning in animal breeding decisions.
Prerequisite(s): BIOL 1105 and (STAT 2004 or STAT 3005 or STAT 3615) and (APSC 1454 or DASC 2474 or DASC 2484)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3204 - Animal Nutrition and Feeding (3 credits)
Characteristics, sources, digestion, absorption, and metabolism of water, carbohydrates, lipids, proteins, vitamins, and minerals. Feeding systems for livestock, poultry and companion animals.
Prerequisite(s): ALS 2304 and (CHEM 1036 or CHEM 1036H or CHEM 1016)
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3304 - Physiology of Reproduction (3 credits)
Physiological mechanisms that control and affect reproductive processes in domestic species. Investigation of the anatomy and physiology of the reproductive systems from cellular to whole-body levels with a particular emphasis on implications for reproductive function.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3314 - Physiology of Reproduction Lab (1 credit)
Investigation of the structure and function of reproductive systems of domestic species. Practical application of this knowledge is then taught through demonstrations, hands-on experiences and assignments exploring current farm-animal production systems.
Corequisite(s): ALS 3304
Instructional Contact Hours: (0 Lec, 3 Lab, 1 Crd)

ALS 3404 - Ecological Agriculture: Theory and Practice (3 credits)
Presents an overview of historic and modern agricultural practices. Surveys the principles of ecology in the context of managed ecosystems, civic agriculture, and food systems. Explores ecologically based practices and their use in holistic and integrated agricultural systems.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4204 - Concepts in Community Food Systems (3 credits)
Examination of the economic, political, socio-cultural, health and environmental issues related to community food systems and agricultural practices. Topics include local, regional and global food systems development, food production and biotechnology, food sovereignty and security, and population and environmental health. Analyze models, strategies, and policies within local, national and global food systems.
Prerequisite(s): ALS 2204
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4214 - Capstone: Civic Agriculture and Food Systems (3 credits)
Multidisciplinary, experiential community-based course focusing on civic agriculture-food systems. Work in partnership with community stakeholders to propose viable solutions to real world issues revolving around civic agriculture and food systems. Connect with communities locally, regionally or globally.
Prerequisite(s): ALS 2204 and ALS 3404 and ALS 4204
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4224 - Food, Agriculture, and Society Capstone Seminar (1 credit)
Explore the interplay between food, agriculture, and society from interdisciplinary perspectives. Engage in student-led discussions, presentations, and critical thinking and synthesizing of capstone experiences embedded within the Food, Agriculture, and Society Pathways minor curriculum. Integrate research, study abroad, internships, or other experiential learning initiatives to gain practical insights toward a more just and sustainable food system. Pre: (ALS 2204 and HIST 1084) and any Study Abroad, Independent Study, or Undergraduate Research course regardless of subject designator.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 4244 - Global Food Security and Health Capstone Experience (3 credits)
Food security and its relationship to human and global health challenges. Role of geography, economics, climate, politics, trade, and culture. Ethical issues and challenges to improving global food security and health. Creatively analyze, synthesize, and evaluate learned knowledge. Participate in successful discourse related to global food security and health.
Prerequisite(s): CSES 2244 and AAEC 3204
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4554 - Neurochemical Regulation (3 credits)
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet.
Prerequisite(s): (ALS 2304 or BIOL 3404) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 4554

ALS 4574 - Social Behavior of Birds and Mammals (3 credits)
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural, companion and laboratory settings are discussed.
Prerequisite(s): ALS 3104 or BIOL 2004 and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 4574

ALS 4614 - Watershed Assessment, Management, and Policy (2 credits)
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: WATR 4614

ALS 4714 - Global Seminar (1 credit)
Student-centered internet-based course including text and real-time video conferencing among students at collaborating institutions in the United States and Canada. Focus is contemporary North American environmental sustainability issues based on student-prepared case studies. Pre-requisite: Junior or Senior Standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: HORT 4714

ALS 4814 - Nutritional Neuroscience (3 credits)
Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity.
Prerequisite(s): NEUR 2026 or ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 4814

ALS 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

American Indian Studies (AINS)

AINS 1104 - Introduction to American Indian Studies (3 credits)
Introduction to the historical richness and complexity of American Indian societies. Examination of American Indian identities, worldviews, past and present sustainability practices, experiences with and resistance to colonial domination and policies, and cultural interchanges with non-Indians.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AINS 2104 - Oral Traditions and Culture (3 credits)
Examination of the worlds great oral traditions, both ancient and contemporary. Emphasis on performance contexts, relationships among multicultural traditions, including American Indian oral traditions, and the relationships among orality, literacy, technology, media, and culture.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 2104

AINS 2414 - Identity and Inclusion in Agricultural and Life Sciences (3 credits)
Examines histories of persons representing different social identities, statuses, space, place, and traditions in agricultural and life sciences. Explores how differences influence experiences individuals may have in agricultural and life sciences. Apply ethical reasoning practices to recognize and addresses critical issues surrounding inclusion of diverse populations within agricultural and life sciences education and leadership.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALCE 2414

AINS 2804 - Contemporary Native American Literatures (3 credits)
This course offers a sampling of fiction, poetry, and non-fiction by the most influential American Indian writers since 1970, authors such as Momaday, Silko, Deloria, Welch, Harjo, and Alexie. Students will also learn about those aspects of cosmology and storytelling traditionally shared by all American Indian Nations, as well as about those aspects specific to the individual tribal traditions from which the authors and their characters come.
Prerequisite(s): ENGL 1106 or ENGL H1204 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2804

AINS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AINS 3174 - Native American History (3 credits)
The Native experience in North America or Latin America from 1491 to present. Emphasis on social diversity and organization, resistance to colonization, leadership and cultural change, and political sovereignty among indigenous peoples. Methods for interpreting a variety of primary sources, including texts, material culture, and archaeological findings. Engagements with shifting historiographical perspectives and political movements for recognition of Native sovereignty.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3174

AINS 3184 - Food Sovereignty (3 credits)
Food sovereignty, the right to produce and consume culturally relevant food, as a set of practices and as a social movement through comparative case studies. Origins of food sovereignty in response to effects of colonialism, the green revolution, and the global corporate food system on peasant and Indigenous subsistence livelihoods and the concept's transformation through dialogue with indigenous agricultural knowledge and poor peoples' environmentalism. Food sovereignty's challenge to the dominant food system and conceptions of development, how groups implement this vision of democratized social and productive relations through projects of agroecology and land reform, and its potential in the context of ecological calamity.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3184

AINS 3304 - The Languages of Native America (3 credits)
Study of the structures of the native languages of the Americas; their interrelationships; their use in individual speech communities; contact with other languages; the interrelationships of linguistic structure, culture, and thought; their future survival.
Prerequisite(s): ENGL 1106 or ENGL H1204 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3304

AINS 3684 - Indigenous Peoples and World Politics (3 credits)
A survey of the historical and contemporary struggles of indigenous peoples throughout the world. Examines the dynamics of colonialism (internal and external), identity construction, gender, cultural integrity, and the ongoing global indigenous rights discourse. In addition to covering broad global processes/theoretical approaches, comparative case studies of particular indigenous groups, such as the Maasai (Kenya, Tanzania) and Mayans (Mexico, Guatemala, Belize), are used to highlight the global, regional, and intra-community diversity among contemporary indigenous peoples.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3684

AINS 4004 - Topics in American Indian Studies (3 credits)
A variable topics course in which students will engage an interdisciplinary methodology to pursue a critical and in-depth examination of various topics concerning and pertinent to American indigenous peoples. This course is repeatable for up to 6 hours credit with different topics. Must meet prerequisite or have permission of the instructor.
Prerequisite(s): AINS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

AINS 4114 - Indigenous Foodways (3 credits)
Examines American Indian worldviews and human-Nature relationships within the context of a dominant non-Indigenous society, through land-based learning including foraging and cultivation. Introduces and contrasts Traditional Ecological Knowledge (TEK) and Scientific Ecological Knowledge (SEK). Encourages the equitable inclusion of Indigenous peoples' practices in the human and environmental sustainability of our collective future, with attention to decolonization and global Indigenous struggles for justice. Student engagement opportunities in hands-on foraging, seed saving, cultivation, and projects around food sovereignty, food security, and revitalization of traditional foodways, in collaboration with local Native communities.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AINS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

AINS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AINS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AINS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AINS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Animal and Poultry Sciences (APSC)

APSC 1454 - Introduction to Animal and Poultry Science (3 credits)
Survey of systems of livestock and poultry production including: concepts and terminology pertaining to management and marketing; types and breeds of livestock and poultry; and an introduction to nutrition, genetics, physiology, and management of beef cattle, horses, sheep, swine and poultry.
Corequisite(s): APSC 1464
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 1464 - Animal and Poultry Science Laboratory (1 credit)
Management practices and concepts related to efficient livestock and poultry production and marketing are taught through demonstrations and hands-on experience.
Corequisite(s): APSC 1454
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 1504 - Animal and Poultry Sciences First Year Experience (1 credit)
Orientation course for freshman and transfer APSC students providing skills, resources and fundamental knowledge to enhance learning experiences and support success. Skills, resources, opportunities, curriculum, and career planning. Emphasis on inquiry, problem-solving skills, critical thinking and integration of ideas and experiences to encourage life-long learning.
Instructional Contact Hours: (1 Lec, 1 Crd)

APSC 1524 - Beginning Equitation (1 credit)
Beginning work in equitation, the science of horseback riding. The five natural aids of the rider and rein aides. Secure positions of the rider's leg and seat at the walk, trot, and canter. Basic leg and seat position for jumping. Concepts of horse welfare, health, behavior, and communication pertaining to horseback riding. The German training scale, including rhythm, relaxation, connection, impulsion, straightness, and collection of the horse. Use of small cavaletti obstacle courses to improve horse strength and straightness. Grooming techniques, hoof care, and tack conditioning for equitation horses. Position emphasis will be on the forward riding seat and elementary dressage movements. COURSE FEE $1,500
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2004 - Animal and Poultry Sciences Seminar (1 credit)
Identification of primary and secondary career objectives for Animal and Poultry Science majors; planning for completion of a capstone learning experience in the major. Identification of curricular and extracurricular activities to increase career opportunities. Improvement of professional and technical writing skills applicable to the animal sciences field.
Prerequisite(s): APSC 1504
Instructional Contact Hours: (1 Lec, 1 Crd)

APSC 2104 - Poultry Laboratory (1 credit)
Anatomy and physiology of birds including species-specific specializations in anatomical structure and body composition, musculoskeletal, respiratory, reproductive, endocrine, digestive and urinary systems. Relationship of these concepts to growth and egg production. Includes handling live birds.
Prerequisite(s): APSC 1454 and APSC 1464
Corequisite(s): ALS 2304
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 2114 - Livestock Management and Handling (1 credit)
Safety in livestock handling; animal behavior; care, housing, and managerial practices related to beef cattle, sheep, and swine taught through experiential activities.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 2124 - Horse Handling Practicum (2 credits)
Stable management, haltering and leading horses, equine vital signs, and hoof care. Identification of horses by coat colors and markings. Breed characteristics of horses. Equine behaviors. Types and amounts of feed and forages commonly fed to horses. Anatomical parts of the horse. Careers in the horse industry and sports in which horses participate. Involvement with daily management and handling of the campus equitation and breeding horses.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

APSC 2164 - Companion and Laboratory Animal Care and Handling (1 credit)
Brief history of companion and laboratory animals. Outline of the major anatomical and physiological characteristics, first aid and basic care. Principles of husbandry and handling techniques. Institutional Animal Care and Use Committee training.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (2 Lab, 1 Crd)

APSC 2424 - Introduction to the Equine Industry (3 credits)
Introduction to the horse and equine industry. Survey of breeds and conformation; breeding, management, equipment, facilities, and marketing of the successful horse operation.
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2524 - Intermediate Equitation (1 credit)
Intermediate work in horseback riding with special emphasis on development of the forward seat and skills required for jumping. Elementary dressage movements. COURSE FEE: $1,500.
Prerequisite(s): APSC 1624
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 2574 - Domesticated Animal Behavior (3 credits)
Behavioral systems, social behavior, learning, and cognition of domesticated animals. Ethological and psychological approaches to, and ultimate and proximate methods of, studying behavior. Evolutionary processes and natural selection, genetics and epigenetics, and neural and physiological mechanisms of behavior.
Prerequisite(s): APSC 1454 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2624 - Beginning Equitation Over Fences (1 credit)
Introduction of jumping skills for the unskilled as well as review of jumping skills for experienced riders. Rider should have skills at trot and canter. COURSE FEE: $1,500.
Prerequisite(s): APSC 2524
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 2714 - Design of Precision Animal Agricultural Systems (3 credits)
Design methods, interpretation, and historical context of precision animal agriculture systems, including technologies, networking, sensors, and data analytics. Elements of animal production systems designed with precision animal agriculture technologies. Advantages and disadvantages of traditional and technology-enhanced production systems. Impacts of precision system design on economics and environmental impacts of animal agriculture and wellbeing. Data acquisition, pipelines, and analytics that link data with decision making. Design of connected systems.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2824 - Equine Conformation and Biomechanics (2 credits)
Evaluation of equine conformation as related to locomotion, athletic performance and soundness. Basic understanding of breed standards, gaits, and rules and regulations pertaining to various equine sports disciplines, from both domestic and global perspectives. Investigation of current scientific literature regarding equine conformation and biomechanics.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

APSC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3024 - Equine Science and Management (3 credits)
Management of horses at maintenance, in light work, and breeding stock. Conformation, forages and concentrate requirements, common diseases and health conditions, health maintenance, vaccination and deworming protocols, behavioral modification and training practices, facility management, breeding practices, and welfare. Career paths in the horse industry. Emphasis on application and analysis of case studies.
Prerequisite(s): APSC 2124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

APSC 3064 - Companion and Laboratory Animal Science (3 credits)
Comparative aspects of companion and laboratory animals including physiology, anatomy, nutrition, genetics and reproduction. Normal behaviors along with techniques of behavior modifications.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3134 - Animal Agriculture and the Environment (3 credits)
Environmental issues associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: DASC 3134

APSC 3214 - Principles of Meat Science (3 credits)
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations.
Prerequisite(s): ALS 2304 and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 3214

APSC 3224 - Meat Science Laboratory (1 credit)
Harvesting of livestock, carcass fabrication into wholesale and retail cuts, fresh meat processing and cookery. Handling, processing and displaying fresh and processed beef, pork, and lamb. Applications of Hazard Analysis Critical Control Point (HACCP) and food safety concepts to meat processing environments.
Corequisite(s): APSC 3214
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 3254 - Animal Products (3 credits)
Products obtained from animals (meat, eggs, dairy, by-products). Effect of production and processing of food animals upon product safety and quality.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

APSC 3334 - Animal Welfare and Bioethics (3 credits)
Historical overview of animal welfare and bioethics. Animal welfare issues in farm and companion animals with respect to their use and treatment in the United States and in the global community. The influences of animal protection organizations, consumer groups, politicians, the scientific community, and other stakeholders on the development and enforcement of policies. Pre: Junior Standing.
Prerequisite(s): APSC 1454 and ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3434 - Host Microbe Interactions (3 credits)
Microbes and their physiology in animal production. Host-microbe interactions at a cellular/system level. Microbial pathogenesis, microbiome, and metabolism in animal health. Cellular responses to microbe colonization of its animal host. Relate microbial metabolism with diet and animal growth and development. Examine the underlying mechanism behind disease or health resulting from microbe interactions.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3504 - Poultry Science and Health (3 credits)
Avian embryology and physiological systems, poultry genetics, microbiome, diseases, biotechnology, health and welfare. Social and economic issues facing the poultry industry.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3524 - Intermediate Equitation Over Fences (1 credit)
Establishment of sound jumping skills. Continuation of more advanced flat work. Study of hunter courses and cross country jumping. COURSE FEE: $1,500.
Prerequisite(s): APSC 2624
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 3624 - Advanced Equitation Over Fences (1 credit)
Advanced methods and techniques for jumping and precision riding. COURSE FEE: $1,500.
Prerequisite(s): APSC 3524
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 3684 - Special Topics in Animal and Poultry Sciences (1,2 credits)
An advanced, variable-content course which explores a topic in the animal sciences such as a significant contemporary issue; an emerging research area of interest to undergraduates; or a semester-long project involving a small group of students. May be repeated for up to three credits, no more than two credits per term.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1,2 Lec, 1,2 Crd)
Repeatability: up to 3 credit hours

APSC 3754 - Principles of Livestock Evaluation (2 credits)
Selection of market and breeding animals based on subjective and objective methods of evaluation. Basic understanding of evaluation principles, form-to-function, expected progeny differences, and performance records of beef cattle, swine, and sheep. Involves accurate decision making and oral reason presentations.
Prerequisite(s): APSC 1454
Instructional Contact Hours: (6 Lab, 2 Crd)

APSC 3764 - Livestock Merchandising (2 credits)
A comprehensive study of the principles and activities involved in successfully promoting and merchandising livestock. A livestock auction (Hokie Harvest Sale) is held at the conclusion of the course to provide experiences in advertising, salesmanship, livestock photography, facility development, sale management, and budgeting. Pre: Junior standing or consent.
Instructional Contact Hours: (2 Lec, 2 Crd)

APSC 3824 - Equine Training and Marketing (2 credits)
Application of fundamental behavioral concepts and principles to the training of horses in routine handling and groundwork. Preparation, marketing and presentation of horses for show and sale.
Prerequisite(s): APSC 2124
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

APSC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4004 - Contemporary Issues in the Animal Sciences (3 credits)
Applying critical thinking, ethical reasoning and problem solving in order to make ethical decisions in regard to important contemporary issues in animal agriculture and other areas of the animal sciences; discourse through oral and written communication.
Prerequisite(s): APSC 2004
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4054 - Genomics (3 credits)
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized.
Prerequisite(s): BCHM 3114 or BCHM 4116 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BCHM 4054

APSC 4064 - Issues in Companion Animal Management (3 credits)
Comparative aspects of companion animals including physiology, anatomy, nutrition, genetics, reproduction and well-being. Normal and aberrant behaviors along with techniques of behavior modification and pharmacological intervention. Critical evaluation of current legal and ethical issues in the companion animal industry. Limited to dogs, cats and caged birds. Pre-requisite: Junior Standing required Pre-requisites may be waived with permission of instructor.
Prerequisite(s): APSC 2464 and ALS 3104 and ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4124 - Equine Health and Disease (4 credits)
Application of principles needed to effectively monitor and manage equine herd health. Focus on information synthesis, situation assessment and decision-making skills to develop preventative care protocols and treat illness. Practical application of horse health care techniques for routine and minor emergency situations.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

APSC 4204 - Advanced Equine Nutrition and Feeding (3 credits)
Analysis, formulation, and improvement of diets fed to horses in different physiological stages and metabolic statuses. Nutrient digestion, absorption, and utilization of nutrients. Computer-based ration formulation for horses. Applying economic principles to ration formulation and communicate equine nutrition concepts.
Prerequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4224 - Equine Exercise Physiology (3 credits)
Comprehensive study of conditioning the equine athlete using the principles of exercise physiology, energetics, kinetics, and sports medicine. Anatomy and physiology as it relates to exercise, conditioning and fitness assessment; exercise intolerance; performance nutrition; and medical practices used to support equine athletics.
Prerequisite(s): ALS 2304 and APSC 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4264 - Companion and Exotic Animal Nutrition (3 credits)
Idiosyncrasies and conformities of digestive systems and metabolic characteristics of cats, dogs, reptiles, small mammals, birds, and fish. Nutrient requirements by life-stage of cats, dogs, reptiles, small mammals, birds, and fish. Food ingredients, software-based pet food formulations, pet food labels, and regulatory frameworks. Modifications of pet food formulations for life stage and physiological conditions. Attributes of food ingredients that impact quality and nutritional value. Pet food packaging nutritional claims. Evaluation of newly emerging information and scientific literature regarding nutritional requirements of cats, dogs, reptiles, small mammals, birds, and fish.
Prerequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4304 - Principles and Practices of Bovine Reproduction (2 credits)
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, uterus and ovary condition. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: DASC 4304

APSC 4324 - Equine Reproduction and Neonatal Care (4 credits)
Principles and techniques in equine reproductive physiology and endocrinology. In-depth examination of equine reproduction strategies combined with practical techniques leading to synthesis and evaluation of breeding decisions. Anatomy and physiology of the mare and stallion, estrus detection and manipulation, artificial insemination, semen handling and processing, parturition and early care of neonates will be covered. Other topics will include selection of breeding stock and mating decisions.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

APSC 4404 - Commercial Poultry Enterprise Management (4 credits)
Production, management, and reproduction of meat- and egg-type chickens and turkeys. Emphasis is on the application of basic poultry science principles as they relate to commercial poultry enterprises. Advanced topics of economic analysis, program management, and problem solving used in decision making processes in integrated poultry operations.
Prerequisite(s): APSC 2104 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4414 - Beef and Sheep Production and Industry (4 credits)
Study of the commercial and purebred beef cattle and sheep industries. Principles and applications for successful and profitable beef and sheep production.
Prerequisite(s): APSC 2114 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4424 - Horse Production and Management (4 credits)
Reproduction, genetics, nutrition, herd health, planning and economics of private and commercial horse farms, and current issues in the horse industry.
Prerequisite(s): APSC 2124 and APSC 2424 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4444 - Swine Production (3 credits)
Principles for commercial and seedstock swine production; current management practices, housing and marketing; issues and challenges in the swine industry. Experience in husbandry, research, and other management techniques obtained during laboratory.
Prerequisite(s): APSC 2114 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

APSC 4464 - Companion and Laboratory Animal Health and Management (4 credits)
Animal health, management, well-being, and government regulation in the maintenance, use and enjoyment of companion and laboratory animals.
Prerequisite(s): APSC 2164 and APSC 3064 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

APSC 4514 - Animal Growth and Development (3 credits)
Meat animal growth and development processes, micro and gross anatomy, stem cell biology and growth, body and carcass composition with application to animal and carcass evaluation.
Prerequisite(s): ALS 2304 and ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4554 - Advanced Livestock Enterprise Management (3 credits)
Application of principles needed to manage profitable and sustainable beef cattle, sheep, and swine enterprises. Use of techniques to develop and evaluate strategies resulting in sound livestock enterprise management decisions. Focus on advanced animal management protocols, enterprise analysis, resource allocation, marketing options and risk management.
Prerequisite(s): APSC 4414 or APSC 4444
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

APSC 4624 - Topics in Equine Science (2 credits)
Review and critique of scientific literature related to equine science. Focus on creative and critical thinking. Principles and practice of information analysis, synthesis and evaluation through discourse and technical writing. Practical application of research and communication skills.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 2 Crd)

APSC 4774 - Nutrition and the Animal Brain (3 credits)
Relationship of diet and nutrients to animal behavior and neurobiology. Nervous system control of feeding behavior and metabolism to regulate whole body energy homeostasis in companion, livestock, and poultry species. Interactions of dietary formulations and nutrients affecting brain physiology and pathology.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4954 - Capstone Experience in Animal and Poultry Sciences (1-19 credits)
Student-defined learning experience that utilizes knowledge and skills already learned to acquire new skills, synthesize information and solve problems in the animal sciences. Requires approval from the department before commencement of the experience, and a final report at its conclusion. Open to APSC majors only. Completion of 75 credits towards the APSC degree required.
Prerequisite(s): APSC 2004
Instructional Contact Hours: Variable credit course

APSC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Appalachian Studies (APS)

APS 1704 - Introduction to Appalachian Studies (3 credits)
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 1704

APS 2124 - Music Traditions in Appalachia (3 credits)
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MUS 2124

APS 2404 - Folk Cultures in Appalachia (3 credits)
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 2404

APS 2434 - The Cultural Politics of Music in Appalachia (3 credits)
Examines cultural, political, and social aspects of music in, of, and about Appalachia, including such commercialized and increasingly globalized products as “old-time,” “bluegrass,” and “country.” Ways in which music contests and reproduces social relations of race, class, and gender. Role of migration and racial diversity in formation of Appalachian music. Economic significance of music, such as Virginia’s The Crooked Road as a regional touristic undertaking.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

APS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 2974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

APS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 3124 - Societal Health in North America (3 credits)
Study of human health within and across a variety of geographic contexts in North America. Describe the health consequences of inequity and injustice within and across American contexts. Consider the roles of collectives, social movements, mutual aid, interdisciplinary thinking, power and social justice in addressing pathologies of power and working towards human well-being. Advocate a biosocial lens that considers the dynamic relationships between biology and environmental, social, geographic, and historical contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3124

APS 3214 - History of Appalachia (3 credits)
Early settlement, religion, the pre-industrial economy, the coming of the coal and lumber industries, labor activism, politics, migration, and regional identity.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3214

APS 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

APS 3624 - Appalachian Literature (3 credits)
Appalachian literature from the region’s beginnings to the present, including such diverse voices as women, Native American, Affrilachian, LGBTQ, and Latinx populations. Literary perspectives on the relationships between self, family, and community; place and displacement; and humans and the natural world. Analysis of stereotypes that have perpetuated inequity and displacement of power, as well as consideration of regional efforts to reclaim equity, power, place, and identity.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3624

APS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4034 - Appalachian Languages and Cultures (3 credits)
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4054

APS 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 4094, SOC 4094

APS 4414 - Issues in Appalachian Studies (3 credits)
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse.
Prerequisite(s): HUM 1704 or APS 1704
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 4414

APS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

APS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Apparel, Housing, & Resour Mgt (AHRM)

AHRM 1014 - Design and Art for Consumers (3 credits)
Overview of art and design principles and elements with a focus on their application in the creation and promotion of apparel, housing, and residential technology products for diverse consumers. Review of historical art and design trends and theories in relation to these products. Interpretative strategies and methodologies in visual art and design. Exploration of the design process, including examinations of human factors and user needs.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AHRM 1104 - Introduction to AHRM and Student Resources (1 credit)
Introduction to the Department of Apparel, Housing, and Resource Management (AHRM), majors and curriculum requirements. Introduces students to experiential learning opportunities, undergraduate research, and career opportunities. Exploration of programs and services to enhance awareness of opportunities and support systems available for student success.
Instructional Contact Hours: (1 Lec, 1 Crd)

AHRM 2014 - Design for Consumers Studio (3 credits)
Exploration and application of design principles and elements in two-dimensional and three-dimensional designs that support the development and promotion of products for diverse consumers, including apparel, housing, residential technologies. Application of skills, tools, and methods to the creation of design. Utilization of the design process to develop plans for consumer products for diverse users. Design Lab/ Studio.
Prerequisite(s): AHRM 1014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (0 Lec, 5 Lab, 3 Crd)

AHRM 2404 - Consumer Rights (3 credits)
Role of consumers in society and in national and international markets. Consumer rights, responsibilities, policies, regulations and redress. Consumer decision making and planned buying. Current consumer issues such as: product safety, food, health care, housing, environmental impact, banking, credit and insurance from an intercultural perspective.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AHRM 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

AHRM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Arabic (ARBC)

ARBC 1105 - Elementary Arabic (3 credits)
Fundamentals of Arabic with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. ARBC 1105 is for students with no prior knowledge of the language.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 1106 - Elementary Arabic (3 credits)
Fundamentals of Arabic with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. ARBC 1106 is for students who have completed ARBC 1105 or the equivalent. Completion of 1106 meets the university language requirement.
Prerequisite(s): ARBC 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 1114 - Accelerated Elementary Arabic (6 credits)
Proficiency-oriented approach to Elementary Arabic, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops speaking, listening comprehension, reading comprehension, writing, and cultural competency at the novice-high level. Duplicates 1105 and 1106. Not recommended for Native Speakers.
Instructional Contact Hours: (6 Lec, 6 Crd)

ARBC 2105 - Intermediate Arabic (3 credits)
2105: First course in the intermediate-level sequence in Arabic. Review of grammar with increasing emphasis on reading, writing, cultural competency, and oral communication.
Prerequisite(s): ARBC 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 2106 - Intermediate Arabic (3 credits)
2106: Second course in the intermediate-level sequence in Arabic. Reinforcement of reading, writing, speaking, listening, and cultural competency skills, allowing students to consolidate and expand on their previous knowledge and preparing them for third-year Arabic. Not recommended for native speakers.
Prerequisite(s): ARBC 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 2774 - Arab Culture and Civilization (3 credits)
Overview of Arab culture and civilization, with an emphasis on the modern Middle East. Familiarizes students with the geography, history, politics and sociology of the Arab world and identifies the cultural forces that shape current events in the region. Explores the impact of colonialism, war, religion, gender relations, and media technologies in the Arab world. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 3105 - Advanced Arabic (3 credits)
3105: First course in the advanced-level sequence in Arabic. Practice in communication skills in Arabic both orally and in writing, including review of grammar, directed composition, and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Second course in the advanced-level sequence in Arabic. Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): ARBC 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3106 - Advanced Arabic (3 credits)
3106: Second course in the advanced-level sequence in Arabic. Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): ARBC 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3124 - Arabic for Oral Proficiency (3 credits)
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. Provides students with the skills necessary to modify the pronunciation and grammar rules of Modern Standard Arabic in order to speak and comprehend conversational Arabic at the intermediate level. Emphasis on speaking, listening comprehension, daily-life experiences, body-language, and cultural knowledge. Not recommended for native speakers.
Prerequisite(s): ARBC 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3274 - War and Arab Culture (3 credits)
Cultural production related to war and violent conflict in the Arab world. Cultural, intellectual, and historical contexts of war in the Arab world. Arab cultural production as a reflection of political, economic, and social change in modern Arab societies, and representations of war in the Arab world in Western cultural production. Explores themes including trauma and memory, displacement, political propaganda, nationalism, and religious and ideological conflict as represented in various genres, including literature, music, and visual art. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3304 - Modern Arabic Literature in Translation (3 credits)
Familiarizes students with the cultural, intellectual, and historical contexts of major Arabic literary texts. Provides students with skills necessary to analyze the rhetorical devices and literary techniques of the texts under study. Texts from major literary genres include poems, short stories and realist and experimental novels. Explores topics including postcolonialism, resistance, war, romance, tradition, religion, feminism, and pop culture. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3474 - Topics in Arab Cinema (3 credits)
Examination of the cultural, intellectual, and historical contexts of Arab cinematic works. Exploration of the ways in which Arab cinema reflects the dynamics of political, economic, and social change in modern Arab societies, as well as how the Arab world is represented in Western films. Variable topics such as war and conflict, terrorism, postcolonialism and movements for national independence, feminism, gender and sexuality, and globalization. Taught in English. Variable content. May be repeated 2 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARBC 3514 - Media Arabic (3 credits)
Reading and listening comprehension, analysis, writing, translation, and cultural conventions pertaining to Arabic print and broadcast media.
Prerequisite(s): ARBC 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 3644 - Religion in the Middle East (3 credits)
Critical issues in religion in the Middle East. Competing methods for analyzing religion in the Middle East. Key concepts relating to religion and inter-religious relations in the Middle East such as minority, majority, tolerance, citizenship, and family law. Critical thinking about the relationship between Islam and other religions with particular reference to Muslim-Jewish and Muslim-Christian relations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3644, RLCL 3644

ARBC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 4104 - Advanced Grammar, Conversation, and Cultural Competency (3 credits)
Focus on enhancing students' conversational skills in formal and colloquial usage, analysis and application of advanced grammatical and stylistic devices, reading and listening comprehension and cultural competence in norms and social practices in the Arab world.
Prerequisite(s): ARBC 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 4154 - Advanced Composition and Stylistics (3 credits)
Intensive work in written Arabic. Devoted to enhance the grammar, stylistics, writing, and cultural competency of Arabic students at the advanced level. Emphasis on analyzing and writing personal, academic, and professional texts, with attentiveness to the cultural conventions common to each genre.
Prerequisite(s): ARBC 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 4334 - Research in Arab Culture (3 credits)
Interpretation of sources about Arab culture. Examination of the historical, intellectual, and cultural contexts of major cultural productions. Integration of authentic Arabic language texts into research. Analysis of the impact of gender, race, and class on cultural productions in the Arab world. Taught in English.
Prerequisite(s): ARBC 2105 and ARBC 2774
Instructional Contact Hours: (3 Lec, 3 Crd)

ARBC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARBC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Architecture (ARCH)

ARCH 1004 - Understanding Community through your Campus (2 credits)
The Virginia Tech campus as both a place and an idea. Explore the physical campus and learn how to recognize its elements. Determine where you are physically, as a community, and as part of an academic tradition. Identification of campus landmarks and navigational exploration. Measure and assess the campus and its spaces and objects, both real and virtual. Place this campus in relation to wider campus ideal and Virginia Tech history. Discussion of custodianship of land by indigenous people and history of black communities in Blacksburg and surrounding areas. Discussion of how and to whom the campus is accessible. Analysis of its buildings, spaces, and branded artifacts in verbal, digital, and drawn representation of the images, forms, and spaces students have observed. Recognition and analysis of both explicit and implicit messages in buildings, objects, and spaces. Come to an understanding of how human-made structures act as stage sets or active frameworks in which we can act out our roles of as members of communities of various kinds and at various scales.
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 1015 - Foundation Design Laboratory (6 credits)
Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgement and critical understanding. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ARCH 1016 - Foundation Design Laboratory (6 credits)
Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgement and critical understanding. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ARCH 1024 - Innovative Design Thinking (3 credits)
Engages students in learning environment of the design laboratory, which is interactive inquiry, experimentation, discovery, and synthesis. Develops thinking and making skills in 2D and 3D across multiple scales. Advances abilities to solve problems through exploring strategies with viable consequences. Engages students in a series of iterative drawing, and modeling exercises relevant to architecture and design education. ARCH 1024 is restricted to incoming freshmen.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 1034 - Seeing Design: Transforming Observations (3 credits)
Introduces students to ways of perceiving, and recording the built and natural environment in Southwest Virginia. Introduces students to travel studies as an essential part of their architecture and design education. Transforms students observational skills. Employs photography and sketching as means of documenting findings. Employs screenprinting and digital technologies as a way to transform documentation. Prepares students for an exhibition of their work, including oral presentations. ARCH 1034 is restricted to incoming freshmen.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 1044 - Life in the Built Environment (3 credits)
Development of the human-made environment has shaped our social relations, culture, and identity. Discussion of how the imposition of built form has served both to define a shared culture and as a means of exclusion and injustice. Study of equity and ethics as evidenced and continued in planning, construction, and public space. Learn how the knowledge of these past structures might shape the future of the built environment in the United States in ways that are more equitable, inclusive, and sustainable.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 1044

ARCH 1115 - Qualifying Design Laboratory (3 credits)
1115: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at a beginners level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgment and critical understanding. Develops fundamental thinking and making skills that advance their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design. 1116: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at an intermediate level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgement and critical understanding. Advances foundational thinking and making skills that develop their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ARCH 1116 - Qualifying Design Laboratory (3 credits)
An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at an intermediate level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgement and critical understanding. Advances foundational thinking and making skills that develop their abilities to solve problems by exploring strategies towards viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design.
Prerequisite(s): ARCH 1115
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ARCH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 2004 - Architecture and Culture: Buildings, Equity and Climate (3 credits)
Interdisciplinary and cross-cultural study of architecture and its context - fundamental architectural ideas, how and why buildings are built, how spaces are occupied and by whom, and how external forces (such as social, political, economic, and environmental) inform architecture's construction and occupation. Examine key buildings from cultures around the world through architectural artifacts, texts, and drawings, employing both disciplinary and interdisciplinary perspectives. Analyze how these buildings operated within diverse cultures to investigate the mutual influence between architecture and its context over time. Develop coherent, evidence-based arguments, drawing on insights from both discipline-specific and interdisciplinary approaches. Develop recommendations for inclusive, equitable, and climate-responsive architecture.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 2015 - Architecture II (7 credits)
Introduction to the theory and practice of architecture. Discipline-specific investigations into how architecture concentrates and conveys natural and cultural influences. Focus on building design as a comprehensive activity balancing numerous concerns including aesthetic, history, materiality, tectonics, and spatial expression. Examination of the relationship between the built and natural environments, including the effects of construction and environmental factors. Qualitative approaches to how architecture contributes to human wellbeing. Identification of relevant areas of interest and modes of inquiry to enrich current work and serve as a basis for self-directed learning. Immersion in the design laboratory ('studio') learning environment. 2015: How architecture concentrates and expresses natural and cultural influences, as well as how it addresses the well-being of individuals and society, through design investigations of varied scales and complexity. Identifying and connecting the fundamentals that comprise the multidimensional wholeness of a work of architecture. Selecting, describing, and analyzing relevant precedents. How architecture and the arts are similar and different, as well as how different fields of knowledge relate to architecture as a cultural and technological production. Discipline-specific modes of communication. 2016: Continued exploration of the dynamic between built and natural environments, including site, environmental forces, and construction impacts; how architecture contributes to human wellbeing. Speculation, development, and communication of architectural proposals. Developing creative source materials by examining a problem from various disciplinary and cultural perspectives. Increasingly complex design work. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 2016 - Architecture II (7 credits)
Introduction to the theory and practice of architecture. Discipline-specific investigations into how architecture concentrates and conveys natural and cultural influences. Focus on building design as a comprehensive activity balancing numerous concerns including aesthetic, history, materiality, tectonics, and spatial expression. Examination of the relationship between the built and natural environments, including the effects of construction and environmental factors. Qualitative approaches to how architecture contributes to human wellbeing. Identification of relevant areas of interest and modes of inquiry to enrich current work and serve as a basis for self-directed learning. Immersion in the design laboratory ('studio') learning environment. 2015: How architecture concentrates and expresses natural and cultural influences, as well as how it addresses the well-being of individuals and society, through design investigations of varied scales and complexity. Identifying and connecting the fundamentals that comprise the multidimensional wholeness of a work of architecture. Selecting, describing, and analyzing relevant precedents. How architecture and the arts are similar and different, as well as how different fields of knowledge relate to architecture as a cultural and technological production. Discipline-specific modes of communication. 2016: Continued exploration of the dynamic between built and natural environments, including site, environmental forces, and construction impacts; how architecture contributes to human wellbeing. Speculation, development, and communication of architectural proposals. Developing creative source materials by examining a problem from various disciplinary and cultural perspectives. Increasingly complex design work. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 2034 - Art of Building (2 credits)
Introduction to architecture identifying the fundamental considerations that contribute to the complex totality of a work of architecture. Interrelationships of context, structure, materiality, and technology toward accommodation and advancement of human activities and well-being. Context as preexisting factors and forces of any given site of architecture, not limited to cultural, historical, geographical, and environmental, including topography and climate. Contemporary precedents emphasizing the diversity of cultural practices and values around the globe.
Prerequisite(s): ARCH 1016
Corequisite(s): ARCH 2015
Instructional Contact Hours: (3 Lab, 2 Crd)

ARCH 2044 - Building Materials (2 credits)
Introduction to the attributes of materials with which buildings are built such as masonry, reinforced concrete, steel, stone, timber, glass and insulation; introduction of the impact of soil, vegetation, watersheds and other natural conditions on buildings and their material fabrication.
Prerequisite(s): ARCH 1015
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 2114 - Sustainability by Design (3 credits)
Design decision-making in complex contexts. Ethical issues underlying design for sustainability. Evaluation of design in systems, products, places, and modes of living using the Framework for Strategic Sustainable Development (FSSD). Historical and cultural underpinnings of design and sustainability.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2114

ARCH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3015 - Architecture III (7 credits)
Architectural design principles, technical concepts, applications, and measures of quality. Ongoing development of key professional skills such as modes of inquiry, problem structuring, drawing and modeling, workflows, and critique. Site, program, structural, regulatory, and environmental influences addressed in architectural formulations. Development of independent interests, research pursuits, and modes of working. 3015: Various materials and techniques of building design. The technical language of describing designed structures. Human experience, health & wellness, user needs, and regulatory standards in the built environment at multiple scales. Analysis of programmatic and site variables that influence design decisions and resource and environmental stewardship objectives. How fundamental design concepts (idea, movement, structure) and human occupation (context, program, experience) intersect with technical constructive knowledges (assembly, materials, building systems). Subjective measures of quality in design. 3016: Continued studies in materials and techniques of building design. Building assemblies documented in technical drawing, modeling, and writing. Interweaving of fundamental design concepts, human occupation, and technical constructive knowledges. How subjective and measurable (resource, environmental stewardship) criteria impact design decisions. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 2016
Corequisite(s): ARCH 3065
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 3016 - Architecture III (7 credits)
Architectural design principles, technical concepts, applications, and measures of quality. Ongoing development of key professional skills such as modes of inquiry, problem structuring, drawing and modeling, workflows, and critique. Site, program, structural, regulatory, and environmental influences addressed in architectural formulations. Development of independent interests, research pursuits, and modes of working. 3015: Various materials and techniques of building design. The technical language of describing designed structures. Human experience, health & wellness, user needs, and regulatory standards in the built environment at multiple scales. Analysis of programmatic and site variables that influence design decisions and resource and environmental stewardship objectives. How fundamental design concepts (idea, movement, structure) and human occupation (context, program, experience) intersect with technical constructive knowledges (assembly, materials, building systems). Subjective measures of quality in design. 3016: Continued studies in materials and techniques of building design. Building assemblies documented in technical drawing, modeling, and writing. Interweaving of fundamental design concepts, human occupation, and technical constructive knowledges. How subjective and measurable (resource, environmental stewardship) criteria impact design decisions. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 3015
Corequisite(s): ARCH 3066
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 3054 - Building Analysis (2 credits)
Study of exemplary built works of architecture through analysis of design documents, interviews, and inspection of actual construction. Course is completed as a group project resulting in both an oral presentation and a written document.
Prerequisite(s): ARCH 3015
Corequisite(s): ARCH 3016, ARCH 3046
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 3065 - Building Materials and Assemblies (3 credits)
Study of what buildings are made of and how buildings are made, in support of architectural design decisions. Attributes of building materials informing their selection and use in buildings. Design and representation of building assemblies, systems, and details, including primary and secondary structural systems, the building envelope, and sub-assemblies, as influenced by formal design ideas, geometry, structure, construction processes, weather resistance, human health and well-being, and environmental impact and sustainability. 3065: Focus on wood, masonry, concrete, and steel construction systems; subsurface conditions and foundations; building codes, life-safety, and accessibility; and basic principles of building envelope systems. 3066: Review of wood, masonry, concrete, and steel construction. Focus on design of building envelope/enclosure wall systems and roofs, including consideration of water resistance, thermal insulation, air infiltration, and vapor control; building cost considerations; and appropriate modes of representation for detailed design decisions.
Prerequisite(s): ARCH 2016
Corequisite(s): ARCH 3015
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3066 - Building Materials and Assemblies (3 credits)
Study of what buildings are made of and how buildings are made, in support of architectural design decisions. Attributes of building materials informing their selection and use in buildings. Design and representation of building assemblies, systems, and details, including primary and secondary structural systems, the building envelope, and sub-assemblies, as influenced by formal design ideas, geometry, structure, construction processes, weather resistance, human health and well-being, and environmental impact and sustainability. 3065: Focus on wood, masonry, concrete, and steel construction systems; subsurface conditions and foundations; building codes, life-safety, and accessibility; and basic principles of building envelope systems. 3066: Review of wood, masonry, concrete, and steel construction. Focus on design of building envelope/enclosure wall systems and roofs, including consideration of water resistance, thermal insulation, air infiltration, and vapor control; building cost considerations; and appropriate modes of representation for detailed design decisions.
Prerequisite(s): ARCH 3065
Corequisite(s): ARCH 3016, ARCH 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3115 - Histories of Architecture (3 credits)
Disciplinary study of architecture across time (pre-history to present) and across continents (Eastern, Western, Northern, and Southern hemispheres). Histories, principles, and factors grounding architecture's expression, form, and methods. Architecture as a cultural production reflective of its social, political, artistic, intellectual, technological, and environmental context. Exploration through artifacts, texts, drawings. ARCH 3115: emphasis on artifacts and architecture between 25000 BCE and 1600 CE; ARCH 3116: includes architectural productions from 1600 CE to present.
Prerequisite(s): ARCH 1015
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3116 - Histories of Architecture (3 credits)
Disciplinary study of architecture across time (pre-history to present) and across continents (Eastern, Western, Northern, and Southern hemispheres). Histories, principles, and factors grounding architecture's expression, form, and methods. Architecture as a cultural production reflective of its social, political, artistic, intellectual, technological, and environmental context. Exploration through artifacts, texts, drawings. ARCH 3115: emphasis on artifacts and architecture between 25000 BCE and 1600 CE; ARCH 3116: includes architectural productions from 1600 CE to present.
Prerequisite(s): ARCH 3115
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3204 - Topics Modules in Architecture History & Theory (1 credit)
Discrete topics in design theory, history, criticism, research methods, and representation. How historic, social, political, technological, and/or economic factors shape the built environment. Historical and contemporary significance of architectural productions within cultural dimensions of human history. How discrete modes of verbal, textual, visual, graphic, or spatial representation influence and reflect understanding relative to architectural form and ideas. May be repeated 2 times with different content for a maximum of 3 credit hours.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3214 - Topic Modules in Building Science and Technology (1 credit)
Focused topics in building technology, systems, materials, construction, assembly and details. Develop scientific expertise that couples quantitative and qualitative dimensions using tools, methods, science, processes of the given field through study, reflection, and application. Utilize empirical knowledge, including building performance, environmental responsibility, and occupant well-being, to advance design excellence. May be repeated 2 times with different content for a maximum of 3 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3224 - Topics Modules in Architectural Media and Methods (1 credit)
Properties and uses of media, materials and processes as tools for analysis, documentation, and presentation of the designed environment. Media properties and processes. Selection of workflows. Appropriate use and maintenance of tools. Iterative design and evaluating outcomes. May be repeated 2 times with different content for a maximum of 3 credit hours. Design Lab/Studio (2L, 1C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (2 Lab, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3234 - Topics Modules in Architecture and Praxis (1 credit)
Specialized topics in the practice of architecture related to designing, planning, and managing the built environment. Factors that inform and impact both design processes and outcomes, such as environmental justice, professionalism, sustainability, inclusivity, and technology. Established and emerging frameworks of architectural practice in fostering the continuous improvement of the discipline. How architects and architecture can contribute to a variety of academic and professional contexts. Teamwork and leadership. May be repeated 2 times with different content for a maximum 3 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3304 - Topics in Architecture History & Theory (3 credits)
Discrete topics in architecture theory, history, criticism, research methods, and representation. How historic, social, political, technological, and economic factors shape the built environment. Historical and contemporary significance of architectural productions within cultural dimensions of human history. The works and ideas of architects, urban planners, historians, theorists, and educators in the context of contemporary architecture. Critical discourse and inquiry. May be repeated 2 times with different content for a total of 9 credit hours.
Prerequisite(s): ARCH 3116
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 3404 - Topics in Building Science and Technology (3 credits)
Focused topics in building technology, systems, materials, construction, assembly and details. Develop scientific expertise that couples quantitative and qualitative dimensions using empirical and design-based tools, methods, science, processes of the given field through study, reflection, and application. Research methods. Representing and communicating research objectives and findings. Using findings to inform decision-making in design. May be repeated 2 times with different content for a maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 3504 - Topics in Architectural Media and Methods (3 credits)
Topics in properties and uses of media, materials, and processes as tools for craft, analysis, documentation, and presentation of the designed environment. Media properties, materials and processes. Selection of workflows. Appropriate use and maintenance of tools. Interplay between media properties and workflows. Iterative design and evaluating outcomes. Parallel practices, techniques, and structures of thinking and making. May be repeated 1 time with different content for a maximum of 6 credit hours. Design Lab/Studio (1H, 3L, 3C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 3604 - Topics in Architecture and Praxis (3 credits)
Specialized topics in the practice of architecture related to designing, planning, and managing the built environment. Develop professional expertise with the knowledge, tools, and processes of the given topic through study, use, and reflection. Existing and emerging theories and frameworks that govern the practice of architecture and its outcomes in the constructed environment. Tools, methods, and practices towards the design of responsive, inclusive, and sustainable works of architecture. Position taken on an individual level within the profession of architecture. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ARCH 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4004 - Architecture IV - Option Lab (7 credits)
Advanced architecture laboratory with specialized design options, off-campus domestic and study abroad opportunities, technical research, and professional internships. Role of design processes in shaping the built environment in response to multiple factors and across diverse contexts. Immersion in professional or specialized settings to contextualize the student's position in the discipline. Development of student-driven course of action for pursuing ongoing professional interests through engagements with, and contributions to, disciplinary research and discourse. Engagement of new territories of inquiry and representation in design work. Critical professional skills in documentation of technical and discursive dimensions of architectural works. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 3016
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 4014 - Architecture IV - Integrative Design (8 credits)
Integration of site, program, constructive systems, and regulatory and environmental frameworks to develop conceptually sound and technically feasible architectural works. Application of design research, including precedent analysis and case studies of existing works. Advanced representation techniques including written, graphic, and physical artifacts. Criticism and dialogue. Individual growth in areas of ongoing interest, research, and modes of study in architectural practice. Repeatable one time, Max. 16 cr. Hybrid Lecture (2H, 2C), Lab (15L, 5C), Design Lab/Studio (2L, 1C) (2H, 17L, 8C)
Prerequisite(s): ARCH 3016 and ARCH 3054
Instructional Contact Hours: (2 Lec, 17 Lab, 8 Crd)
Repeatability: up to 16 credit hours

ARCH 4034 - Building Cities (3 credits)
Analytical studies in the historical evolution of cities, towns and villages. Comparative studies of urban form in relation to their constructive and imaginative means with an emphasis on modern construction processes. Specific case studies in designing and building cities.
Corequisite(s): ARCH 4016
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4044 - Professional Practice in Architecture (3 credits)
Role and responsibilities of the profession on the environment, public health, and social welfare. Professional ethics. Contributions to policymaking and the building enterprise through leadership, advocacy, and civic engagement. Issues of equity, diversity, and inclusion in the profession, the environments where we practice, and the places we design. Roles, responsibilities and viewpoints of the commissioning, design, and construction ensemble. Contracts, compliance, and risk management. Starting, running, and maintaining a profitable architecture practice to achieve design goals. Methods and technologies for delivering projects. Leadership and professional communication skills, including oral, written, and visual presentations, negotiations and conflict resolution, and interpersonal communication in collaborative teams, interviews, and public meetings. Pursuing licensing, specialization, and/or nontraditional career trajectories. Change and future practice forms.
Prerequisite(s): ARCH 3016
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4055 - Environment and Building Systems (3 credits)
A design oriented study of environmental forces, environmental impacts of the built environment, and related building environmental control, life safety and service systems, with concern for the human psycho-physical impacts of building form and systems performance.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4056 - Environment and Building Systems (3 credits)
A design oriented study of environmental forces, environmental impacts of the built environment, and related building environmental control, life safety and service systems, with concern for the human psycho-physical impacts of building form and systems performance.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4075 - Building Structures (3 credits)
Building structures in steel, timber, and reinforced concrete; design of typical components: beams, slabs, columns, beam-columns, connections, and foundations; design of retaining walls; the resistance of buildings to gravity and lateral force action; building stability; floor/roof framing systems; design of simple buildings.
Prerequisite(s): ESM 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4076 - Building Structures (3 credits)
Building structures in steel, timber, and reinforced concrete; design of typical components: beams, slabs, columns, beam-columns, connections, and foundations; design of retaining walls; the resistance of buildings to gravity and lateral force action; building stability; floor/roof framing systems; design of simple buildings.
Prerequisite(s): ESM 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4114 - Ideas, Concepts, and Representations of Architecture (3 credits)
Disciplinary study of ideas, concepts, and representations that have shaped architecture across time (Common Era). Emphasis on ideational constructs and their varied modes of transmission (from textual to oral communications, drawings to images, buildings to models) in relation to the projecting of architecture. Architectural theories and their transmission as cultural productions reflective of societal, ethical, intellectual, environmental, and technological contexts. Presentation and reflection upon architectural discourse itself through written and oral communication.
Prerequisite(s): ARCH 3015 and ARCH 3116
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4124 - Advanced Topics in Architecture History & Theory (3 credits)
Advanced design theory, history, critique, study, and representation. How history, politics, technology, and economics affect architecture and the built environment. Architectural significance. Architectural social, economic, and cultural content. Direct observation, reading, and discourse in architectural criticism. Course may be repeated with different content 2 times for a maximum of 9 credit hours.
Prerequisite(s): (ARCH 3204 or ARCH 4114) and ARCH 3304
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 4144 - Advanced Building Structures I (3 credits)
Study of long-span building structures. Introduction to geometry, form, and structure of folded and bent surfaces. Study of space grid geometry, close-packing systems, and cellular tensegrity. Approximate design of folded plate structures, single and double curvature shells, single and double layer space frames, suspension roofs, tents, and pneumatic structures.
Prerequisite(s): ARCH 4075 and ARCH 4076
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4154 - Advanced Building Structures II (3 credits)
Study of highrise structures ranging from building slabs and blocks, terraced buildings, and skyscrapers to towers. The complexity of load action including wind, earthquake, and hidden loads. The effect of building height, form, and proportion on force action; considerations of stability and redundancy. Preliminary design of masonry buildings, core structures, suspension buildings, braced skeletons, rigid frames, interstitial systems, staggered truss buildings, tubes and hybrid structures.
Prerequisite(s): ARCH 4075 and ARCH 4076
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4224 - Advanced Topics in Building Science and Technology (3 credits)
Advanced topics in building technology, systems, materials, construction, assembly and details. Develop expertise that couples quantitative and qualitative dimensions using tools, methods, science, processes of the given field through study, reflection, application and dissemination of findings. Norms of communicating findings. Applying research findings to design. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4324 - Advanced Topics in Architectural Media and Methods (3 credits)
Advanced topics in architectural media, materials, and processes as tools for analysis, documentation, and presentation of the designed environment. Relationship between media characteristics and processes, applied to a wide range of media types and areas of study. Selection of appropriate tools and workflows. Managing and maintaining toolsets and workspaces. Forms of design research and innovation. Iterative design and evaluating outcomes. Creative practice and discourse. May be repeated 1 time with different content for a maximum of 6 credit hours. Design Lab/Studio (1H, 3L, 3C).
Prerequisite(s): ARCH 3504
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4414 - Advanced Environment Building Systems (3 credits)
Advanced studies of environment and building systems, including development in building systems, urban systems, service systems, construction systems, materials and component systems, psycho-physical considerations, systems analysis, and computer technology. May be repeated for a maximum of 9 credit hours in varied options offered.
Prerequisite(s): ARCH 4055 and ARCH 4056
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 4424 - Advanced Topics in Architecture and Praxis (3 credits)
Advanced topics in the practice of architecture related to designing, planning, and managing the built environment. Innovative knowledge, frameworks, and models for an increasingly just, adaptable, and built environment and profession. Alternative approaches to defining, creating, and value for clients, communities, and employees. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 4044
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4434 - Architectural Lighting Design (3 credits)
Advanced level lecture course focused on lighting. Impact on, need for and measurement of light for humans and the built and natural environments. Selection of color, light sources, equipment and controls. daylight integration. Lighting design, visualization and calculations through hand and digital methods. Evaluation of lighting system energy efficiency and cost. Presentation of lighting design.
Prerequisite(s): ARCH 4055 and ARCH 4056
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4514 - Thesis Inquiry (3 credits)
Student-led, design thesis project research articulated by an aggregated, reflective record of the first semester design work of ARCH 4515-4516 (Architecture V) through an appropriate array of representational means, such as writing, models, images, and drawings. Schematic, critical compilation of ideational and physical process includes critique, evaluation, and presentation of historical, contextual, professional, ethical, and aesthetic considerations; conceptual and theoretical foundations; development of the project's parameters and its design. Course contact to credit hour structure: Lecture (1H, 1C), Lab (3L, 1C), Design Lab/Studio (1.5L, 1C).
Prerequisite(s): ARCH 4004 and ARCH 4014
Corequisite(s): ARCH 4515
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Lab, 3 Crd)

ARCH 4515 - Architecture V (6 credits)
Advanced design and research to produce an architectural project. Demonstration of a conceptual and professional position through a work of architecture. 4515: Student-led focus on identifying research field; probing professional interests; developing conceptual and project parameters; proposing and evaluating design through varied means of public dialogue, critique, and self-reflection. 4516: Emphasis on resolution of project, formal documentation and presentation of work, communication of conceptual position, and assertion of professional trajectory. Hybrid Lecture (1H,1C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (1H,14L,6C)
Prerequisite(s): ARCH 4004 and ARCH 4014
Corequisite(s): ARCH 4514
Instructional Contact Hours: (1 Lec, 14 Lab, 6 Crd)

ARCH 4516 - Architecture V (6 credits)
Advanced design and research to produce an architectural project. Demonstration of a conceptual and professional position through a work of architecture. 4515: Student-led focus on identifying research field; probing professional interests; developing conceptual and project parameters; proposing and evaluating design through varied means of public dialogue, critique, and self-reflection. 4516: Emphasis on resolution of project, formal documentation and presentation of work, communication of conceptual position, and assertion of professional trajectory. Hybrid Lecture (1H,1C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (1H,14L,6C)
Prerequisite(s): ARCH 4514 and ARCH 4515
Corequisite(s): ARCH 4524
Instructional Contact Hours: (1 Lec, 14 Lab, 6 Crd)

ARCH 4524 - Thesis Documentation (3 credits)
Formal documentation of the architectural design thesis, a terminal design project with a conceptual and professional position in the final, fifth year of the professional degree program. Thesis project, process, concept, research, and ethical position presented through drawings, images, and writings. Preparation of portfolio quality document demonstrating architectural ability within discipline and profession. Course contact to credit hour structure: Lecture (1H, 1C), Lab (3L, 1C), Design Lab/Studio (1.5L, 1C).
Prerequisite(s): ARCH 4514 and ARCH 4515
Corequisite(s): ARCH 4516
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ARCH 4705 - Qualifying Design Seminar (3 credits)
Exploratory overview of selected theories and issues relevant to the design and use of the environment. 4705: Emphasis on history, human behavior, and environmental context as it relates to architecture. 4706: Presentation and discussion of the nature of principal construction materials in relation to building design. Characteristics of primary structural materials: wood, steel, concrete, masonry; environmental control systems; supporting technologies. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4706 - Qualifying Design Seminar (3 credits)
Exploratory overview of selected theories and issues relevant to the design and use of the environment. 4705: Emphasis on history, human behavior, and environmental context as it relates to architecture. 4706: Presentation and discussion of the nature of principal construction materials in relation to building design. Characteristics of primary structural materials: wood, steel, concrete, masonry; environmental control systems; supporting technologies. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4715 - Qualifying Design Laboratory (9 credits)
4715: Design laboratory in which student and faculty teams explore the nature of problems and potentials with which architecture is concerned, and experimentally develop methods and process through which existing contexts are transformed into new conditions. 4716: Provides introduction to basic concepts of building structures, materials, and enclosure systems, and appropriate site and climate responses. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 18 Lab, 9 Crd)

ARCH 4716 - Qualifying Design Laboratory (9 credits)
4715: Design laboratory in which student and faculty teams explore the nature of problems and potentials with which architecture is concerned, and experimentally develop methods and process through which existing contexts are transformed into new conditions. 4716: Provides introduction to basic concepts of building structures, materials, and enclosure systems, and appropriate site and climate responses. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 18 Lab, 9 Crd)

ARCH 4904 - Professional Studies (1 credit)
Instructional Contact Hours: (1 Lec, 1 Crd)

ARCH 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Architecture, Arts, and Design (AAD)

AAD 1004 - Exploring Architecture, Arts, and Design (2 credits)
First-Year Experience course for Explore AAD majors. Overview of the college and its degrees, majors and minors, and career opportunities available to CAUS graduates. Presents college and university resources and services that support student success. Introduces students to the basic principles of the research process by focusing on inquiry, problem-solving, and integration of ideas and experiences within the fields in the College of Architecture, Arts, and Design.
Instructional Contact Hours: (2 Lec, 2 Crd)

AAD 1204 - Thinking Globally (1 credit)
Seminar for first-year students enrolled in Rhizome Living-Learning Community. Introduction to systems thinking. Simple and complex systems. Systems approach to sustainable development. International perspectives on, and goals for, sustainable development. Considers United Nations Sustainable Development Goals (SDGS), SDGs History, global progress towards SDGs and Criticisms of SDGs and United Nations. Exploration of Rhizome LLC yearly theme.
Instructional Contact Hours: (1 Lec, 1 Crd)

AAD 1214 - Acting Locally (2 credits)
Course for first-year students enrolled in Rhizome Living-Learning Community. Project-based learning through student-client collaborations. Applies systems thinking concepts and United Nations Sustainable Development Goals. Introduces design thinking as a model for problem solving, including problem definition and iteration. Student presentations, proposal development, exhibition, client feedback and peer critiques.
Prerequisite(s): AAD 1204
Instructional Contact Hours: (2 Lec, 2 Crd)

AAD 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

AAD 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

AAD 3984M - Special Study (3 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: (3 Lec, 3 Crd)

AAD 4234 - Capstone Collaborations: Cross-Disciplinary Teams (3 credits)
Collaborative cross-disciplinary research teams support discipline-specific capstones. Analyzes the interactive relationships between place, space, identity, and community in the United States and beyond. Engages in iterative research processes through reflective teamwork addressing complex problems in senior capstone projects. Synthesizes multiple, complex sources and creates coherent arguments including ethical analyses.
Prerequisite(s): ENGE 2094 and PHIL 3334
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

AAD 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 5954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

Art and Art History (ART)

ART 1004 - Topics in Studio Art for Non-Majors (3 credits)
Variable introductory topics on practice-based studio art, ranging from 2D, 3D and Digital Imaging concentrations. Multiple projects with emphasis on media specific creations using introductory studio practices, practice-based technical and conceptual knowledge to achieve expressive communication. Analyze and critique creative works within historical and cultural context. May be repeated with different topics, for a maximum of 12 credit hours. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). COURSE FEE: $60.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 1104 - Language of Visual Arts (3 credits)
Introduces key formal structures across the broad variety of disciplines in the visual arts and built environment, including: architecture, painting, sculpture, photography, and film. Considers global objects and sites from an intercultural perspective, examining how various formal elements impact our experience and function to construct meaning for audiences. Writing informed arts criticism grounded in local and regional cultural resources. RESOURCE CHARGE.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 1204 - Principles of 2D Art and Design (3 credits)
Elements and methods fundamental to two-dimensional art and design. Investigates formal elements and principles of two-dimensional design including shape, color, balance, rhythm, hierarchy, and unity. Exploration of analog and digital strategies in image making through iterative, hands-on processes. Interpretation of historical and contemporary two-dimensional art and design from around the globe to discover communication strategies in an intercultural context. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1214 - Principles of 3D Art and Design (3 credits)
Elements and methods fundamental to three-dimensional art and design. Investigates formal elements and principles of three-dimensional design including line, plane, form, mass, space, scale and surface. Exploration of analog and digital strategies in three-dimensional object making through iterative, hands-on processes. Interpretation of historical and contemporary three-dimensional art and design from around the globe to discover communication strategies in an intercultural context. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1234 - Topics in Visual Communication Design for Non-Majors (3 credits)
Variable introductory topics on visual communication design, ranging from contemporary issues in design to development of formal design skills. Multiple projects with emphasis on problem-solving with an awareness of target audiences from various backgrounds, historical and cultural contexts, and STEEP (Social, Technological, Economical, Environmental, and Political) principles. Explores knowledge of design principles and vocabulary using a range of materials and methodologies. Examines needs of diverse users, applied via digital translations and appropriate software. May be repeated for up to a maximum of 12 credit hours with varying or different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 1304 - Gateway to Art and Design (1 credit)
First Year Experience course for students seeking entry into BFA degree program. Developing a successful path of study in the School of Visual Arts BFA degree using advising resources; introduction to professional and ethical visual arts practices through presentations with local and regional artists; visits to local and regional galleries; presentations by university faculty and staff related to the BFA. Introduction to visual thinking using the Virginia Tech Common Book and preparation for portfolio review. Art History majors are not required to take the course.
Corequisite(s): ART 1204, ART 1404, ART 1604
Instructional Contact Hours: (1 Lec, 1 Crd)

ART 1334 - Themes in Visual Arts and Cultures (3 credits)
Introduction to thematic topics spanning historical and contemporary world cultures through the lens of the visual arts and material culture. Ten themes to be addressed each semester, each approached through a range of different periods, cultures, media, and artistic traditions, and complemented by culture-specific textual sources. Sample themes might include art and political propaganda, art and technology, art and sustainability, art and death, etc. Does not count towards the art history major.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 1404 - Principles of Drawing (3 credits)
Elements, methods and skills fundamental to drawing. Investigates formal elements fundamental to drawing such as line, space, form, value and texture, through drawing tools and methods. Emphasis on controlled use of common drawing media for representational and expressive purposes. Examination of multiple intercultural viewpoints through exercises and discussion investigating topics that vary by semester. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1414 - Drawing II: Life Drawing (3 credits)
Drawing the human figure from life. Emphasis on observation, construction, and anatomy. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1404 and ART 1204 and ART 1604
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1504 - Contemporary Art and Practice (3 credits)
Methods and practices fundamental to the making of contemporary visual art. Non-discipline-specific investigation of self-expression, meaning, and content through iterative, practice-based exercises. Development of personal artistic practice through the lens of contemporary art and its historical precedents. Exploration of various processes such as representation, abstraction, assemblage, performance, installation, mark making, digital, and time-based, or interactive experiences as means to self-expression and interpretation of meaning. Examination of multiple worldviews and global challenges addressed in contemporary art. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). (1H, 5L, 3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1604 - Principles of 4D Art & Design (3 credits)
Elements and methods fundamental to digital art and design as well as time-based media. Investigation of formal elements specific to four-dimensional design including time, motion, and sound and skills sets in vector and raster graphics and video editing. Exploration of iterative process in digital image making. Interpretation of historical and contemporary digital art and time-based media from around the globe to discover communication strategies in an intercultural context. Examination of multiple worldviews and global challenges addressed in and relevant to digital art and time-based media such as surveillance and questions of privacy. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H, 5L, 3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1614 - Principles of Visual Communication Design (3 credits)
Introduction to design theory, practice, and visual communication skills. Projects, applied problem solving, reading assignments, and open critiques incorporate graphic competencies and vocabulary specific to the field of visual communication design. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 1984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

ART 2385 - Survey of the History of Western Art (3 credits)
Survey of the visual arts and architecture from prehistoric times to the present day with emphasis on Western Europe including functions of visual arts and architecture, terms of visual literacy and methods of formal visual analysis. 2385: Focus on prehistoric time to the thirteenth century including Paleolithic, Neolithic, Ancient Near Eastern, Egyptian, Aegean, Greek, Roman, Byzantine, medieval and early Gothic art. 2386: Focus on late Gothic through present day including Renaissance, Baroque, 19th (Romanticism to Post-Impressionism) and 20th centuries (cubism to postmodernism).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 2386 - Survey of the History of Western Art (3 credits)
Survey of the visual arts and architecture from prehistoric times to the present day with emphasis on Western Europe including functions of visual arts and architecture, terms of visual literacy and methods of formal visual analysis. 2385: Focus on prehistoric time to the thirteenth century including Paleolithic, Neolithic, Ancient Near Eastern, Egyptian, Aegean, Greek, Roman, Byzantine, medieval and early Gothic art. 2386: Focus on late Gothic through present day including Renaissance, Baroque, 19th (Romanticism to Post-Impressionism) and 20th centuries (cubism to postmodernism).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 2434 - Introduction to Creative Code (3 credits)
Introduction to computer programming tools within a critical aesthetic context. Tools may include software such as Processing and Unity. Application of foundational programming techniques to artwork creation. Consideration of computational and quantitative technologies and processes ethically, culturally, and artistically. Algorithmic thinking, and examination of existing computer-generated artworks to infer algorithmic basis. Consideration of the ethics of algorithmic systems in our culture and media. Course contact to credit hour structure: Design Lab/Studio.
Prerequisite(s): ART 1604
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2514 - Drawing Concepts (3 credits)
Exploration of drawing practices that reflect expansions in the discipline through examination of the work of contemporary artists and discussion of recent historical precedents. Examination of multiple viewpoints through readings and discussion investigating notions of identity, culture, and social reality. Development of personalized visual language and content through iterative drawing processes. Application of formal analysis and interpretive strategies through critique. Includes traditional and experimental techniques; representational, abstract, and nonobjective approaches to drawing. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1404
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2524 - Introduction To Painting (3 credits)
Exploration of painting practices within a studio-focused environment as they relate to art and design in contemporary culture as well as historical methods. Development of foundational painting skills and an understanding of various painting media. Deliberate practice of visual language and formal ideas using painting media with a focus on material, line, shape, color, and two-dimensional composition. Interpretation of visual culture through the application of critical analysis methods. Encompasses observation-based techniques, experimental processes, and abstract approaches. Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE: $75
Prerequisite(s): ART 1204 or ART 1404 or ART 1414
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2554 - Introduction To Sculpture (3 credits)
Introduction to the tools, techniques, and concepts of sculpture. Development of visual style, three-dimensional composition and communication through iterative assignments. Application of formal analysis and interpretive strategies through critique. Exploration of genres and practices of sculpture by analyzing contemporary examples and historical precedents. Examination of diverse viewpoints through readings and discussions on the role of sculpture in identity, culture, and politics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 1214
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2565 - Typography (3 credits)
Foundational study of Typography as it relates to Visual Communication Design including historical and contemporary context. Study of the formal principles of typographic design of both printed and digital matter. Overall focus on letterforms, design structures, and grid systems. Pre: Admittance to Visual Communication Design Program. 2566: Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. Pre: 2565. 2565: I, II. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2566 - Typography (3 credits)
Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2566H - Typography (3 credits)
Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2575 - Introduction to Graphic Design (3 credits)
Introduction to the theory and practice of graphic design as a means of visual communication, exploring problem-solving as applied to design concepts and execution. Studio assignments relating to society, industry, community, and commerce, with emphasis on digital/electronic applications. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565
Corequisite(s): ART 1414
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2576 - Introduction to Graphic Design (3 credits)
Introduction to the theory and practice of graphic design as a means of visual communication, exploring problem-solving as applied to design concepts and execution. Studio assignments relating to society, industry, community, and commerce, with emphasis on digital/electronic applications. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2604 - Introduction to Creative Technologies (3 credits)
Introduction to the formal elements, skills, tools and methods of productions used in Creative Technologies to make art/media works. These art works/media works include: sound, video narratives/short films, 2D animation, code/procedural artworks that exhibit meaning and relevance to contemporary society. Integrate, articulate and defend positions on ethical issues to make work that is relevant to the world we live in. Design Lab/Studio.
Prerequisite(s): ART 1604
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2664 - Introduction to Photography (3 credits)
Introduction to the tools, techniques, and concepts of digital photography. Development of visual style, two-dimensional composition, and visual communication through iterative assignments. Application of formal analysis and intercultural interpretation of photographs through class critique as well as historical and contemporary examples. Examination of diverse viewpoints through readings and discussions on the role of photography in identity, culture, and politics. Course contact hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 1204 or ART 1604
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2704 - 3D Computer Animation (3 credits)
ntroduction to the basic principles of 3d-computer animation including modeling, texture mapping, lighting, and motion. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) RESOURCE CHARGE.
Prerequisite(s): ART 1604
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3004 - Topics in Art History (3 credits)
Rotating topics from all periods of art history with a particular emphasis on non-Western art, such as Japanese, Chinese, pre-Columbian, sub-Saharan, Native American, or Islamic art and architecture. Lecture and/or undergraduate seminar format. May be repeated for credit with different content for a maximum of 9 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 3024 - History of Global Print Culture (3 credits)
Global print culture with an emphasis on visual arts and design forms across geographies in cultural contexts. Compares diverse print cultures from their inceptions through today, across historical traditions of East Asia, Mexico, United States, the Islamic world, and Europe. History, social meaning, issues of equity, race, and identity. Print culture's inception through today connects contemporary digital world to its conceptual and material origins.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3034 - Survey of Latin American Art and Architecture (3 credits)
A broad chronological survey of the visual arts and architecture of Latin America with a focus on South, Central, and North America from the rise of ancient indigenous cultures through today. Pre-Columbian iconography, styles, and cultural contexts of Olmec, Inca, Maya, and Aztec societies. European contact and colonial influence in South and Central Americas of the New World. Modern and contemporary art in these regions, with an emphasis on Latinx diaspora visual culture in the United States.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3044 - Art and Architecture of India (3 credits)
Survey of the arts, architecture, and contributions to design history from the subcontinent of India. Iconography and visual elements of Jain, Hindu, Buddhist, Islamic, and Sikh traditions in terms of key works of art, architecture, and design. Interpreted within contexts of religion, historical events, social status, patronage, race, and colonialism. Considers the influence of India's art, architecture, and design histories from antiquity through diasporas today, including US South Asian communities.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3054 - Islamic Art and Architecture (3 credits)
Survey of the visual arts and material culture produced in Islamic cultures from its origins in the 7th century CE (Common Era) through the contemporary period. Focus on analyzing transnational exchanges and influences that shape the visual and material culture of Islamic regions including architecture, the graphic arts, painting, ceramics, and textiles within cultural, geographic, political, and religious contexts. Includes artifacts and architecture from Iraq, Iran, the Arabian Peninsula, Egypt, Turkey, India, Spain and notable sites from North Africa and Central Asia.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3064 - Arts of China and Japan (3 credits)
An introduction to Chinese and Japanese art from the Neolithic to the present. The influence of philosophy, religion and social organizations on the development of the visual arts in China and Japan. Considers a range of media including painting, sculpture, calligraphy, ceramics, prints, and architecture in contexts of Imperial and post-Imperial patronage.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3074 - Egyptian Art and Architecture (3 credits)
Introduction to Egyptian art and architecture from the Predynastic through the Late Period with emphasis on the major monuments of Egyptian sculpture, painting and architecture. Emphasis on Egyptian art in the context of the unique landscape of the Nile River and surrounding desert, the art of contemporary cultures in the eastern Mediterranean world, and the history of archaeological exploration within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3084 - Greek Art and Architecture (3 credits)
Painting, sculpture, and architecture of the Greeks, ca. 1000-31 B.C. Emphasis on correlation of archaeological remains with literary sources, and on the development of the arts in relation to cultural environments of the archaic, classical, and Hellenistic periods.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3114 - Creative Coding for Creativity and Innovation (3 credits)
Introduction to computer programming tools within a critical aesthetic context. Creation and analysis of generative and algorithmic artwork as well as consideration of how works derived from logical rulesets, algorithms, and the artful application of randomness can communicate human feelings and ideas. Consideration of ethics of algorithmic systems in our culture and media, and creating art works to address those issues and influence opinion. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C).
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3174 - Introduction to Archaeology (3 credits)
Introduction to archaeology focusing on a history of the discipline of archaeology with an emphasis on Mesopotamia and the Mediterranean world. Evolution of field inquiry and techniques in the context of major historical personages and excavations in Egypt, Greece, Italy and Syro-Palestine, as well as contemporary global and ethical issues surrounding the preservation and protection of archaeological artifacts, particularly with regards to the role they serve and their use and misuse as non-renewable global objects of cultural heritage and cultural identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3184 - Roman Art and Architecture (3 credits)
Survey of Roman art including painting, sculpture and architecture from ca. 750 BCE to 350 CE. Emphasis on diverse artistic themes connecting visual and material culture with contemporary political and cultural circumstances and the impact of Roman imperial expansion on regional cultures. Historical impact of Roman artistic achievements and activities.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3284 - Medieval Art and Architecture (3 credits)
Artistic traditions of the medieval world from the fourth to fifteenth centuries with a focus on diverse cultural exchanges between Byzantine east and Latin west, along with Islamic contact. Stylistic, thematic, and formal developments in sculpture, painting, textiles, metalwork, architecture, book arts within social, political, and religious contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3384 - Renaissance Art and Architecture (3 credits)
A chronological survey of Renaissance art analyzing painting, sculpture, the graphic arts, and architecture. Develops visual literacy through an evaluation of major stylistic and thematic trends within the study of historical context, artistic techniques and processes, iconography, patronage, economy, religion, political structures, and emerging sciences.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3484 - Baroque and Rococo Art and Architecture (3 credits)
Art and architecture of the seventeenth-century Baroque and eighteenth-century Rococo with with an emphasis on form, style, and cultural contexts for painting, sculpture, and architecture. A study of major artists, themes, styles, and technical artistic processes in Italy, Spain, Flanders, Holland, England, France in contexts of global expansion. Seventeenth-century visual culture in its historical, religious, economic, social, and ethical contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3504 - Topics in Digital Art and Design (3 credits)
Rotating topics that explore the computer as an artistic medium and design tool. Intermediate level. The student will encounter as interdisciplinary approach to the use of the computer, as aesthetic ideas are presented and various digital techniques are applied. Stresses use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated with different content for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) Resource Charge.
Prerequisite(s): ART 2604
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3514 - Topics In Drawing (3 credits)
Rotating topics in drawing media, approaches, and theories. All topics will be devoted to promoting individual student creativity, mastery of drawing means and techniques, and further understanding of graphic concerns. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). May be repeated for a maximum of 9 hours with different topics. RESOURCE CHARGE.
Prerequisite(s): ART 2514
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 3524 - Topics In Painting Media (3 credits)
Rotating topics in painting techniques, disciplines, and theory emphasizing individual creative development and skilled approaches to technical problem-solving in visual art and design. Intermediate level. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2524
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3554 - Topics In Sculpture (3 credits)
Rotating topics that will focus on specific technical processes and applications of three dimensional problem solving in the visual arts. The course will stress techniques and issues found in contemporary 3D art and design. Emphasizes intensive studio practice through a series of individual projects related to the topics. FEES REQUIRED. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2554
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3564 - Topics in Photography (3 credits)
Rotating topics in photographic materials, methods and philosophies. All topics promote individual students creativity, master of photographic techniques and further understanding of the medium. May be repeated with different topics for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 2664
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3565 - Intermediate Graphic Design I and II (3 credits)
Intermediate design layout, technical and concept development, and communication skills. First semester emphasizes advanced and new software relevant to the design, advertising, and printing industry. Second semester focuses on typography, professional pre-press, electronic printing and color separation processes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3566 - Intermediate Graphic Design II (3 credits)
Intermediate design layout, technical and concept development, and communication skills. First semester emphasizes advanced and new software relevant to the design, advertising, and printing industry. Second semester focuses on typography, professional pre-press, electronic printing and color separation processes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). FEE REQUIRED.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3574 - Topics In Graphic Design (3 credits)
Rotating topics in graphic design, for the intermediate level student. This course will encourage visual problem-solving, conceptual development, clarity and individuality of expression. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2576
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3584 - Nineteenth Century European Art: Neoclassicism to Post-Impressionism (3 credits)
European art and material culture of the nineteenth-century. A chronological study of the major artists, artistic movements and styles from neoclassicism to post-impressionism. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, ethnicity and colonialism in the production of art and material culture.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3604 - Topics in New Media Art (3 credits)
Rotating topics explore the computer as an artistic medium and design tool. An interdisciplinary approach to the use of a computer. Aesthetic ideas and application of digital techniques. Use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 2604
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3674 - History of Photography (3 credits)
A chronological history of photography, from its invention in the nineteenth-century to the emergence of digital technology. Emphasis on historical, sociological, cultural, and global contexts. Addresses terminology and visual analysis, inventions, individual photographers, famous photographs, and issues of inclusion and critical discourse.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3684 - African-American Art (3 credits)
African-American art and material culture, from its beginnings in the tribal traditions of Africa to its contemporary manifestations. A chronological study of the major artists, movements and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3704 - Topics in Computer Animation (3 credits)
Rotating topics that explore the artistic and design potential of computer animation. Using current digital techniques and methods, focus is on the creation and manipulation of virtual character designs. Students will use an interdisciplinary aesthetic approach to investigate computer animation concepts. May be repeated for credit maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 2704
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3774 - History of Modern Graphic Design (3 credits)
A chronological survey of the history of modern graphic design, from the mid-19th century to 1980.
Prerequisite(s): ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3784 - European and American Art Since 1900 (3 credits)
European and American Art since 1900. A chronological survey of painting and sculpture from neo-impressionism through post-modernism.
Prerequisite(s): ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3854 - Professional Studio Practices (3 credits)
An overview of professional studio art practices, concepts, marketing strategies and promotional materials. The international exhibition system and current educational opportunities, employment and career options in the visual arts are presented. Preparing of written materials and documenting artwork, building a professional portfolio for presentation to potential employers, art galleries and exhibitions are stressed. Pre: Bachelors of Fine Arts (BFA) majors only.
Prerequisite(s): ART 1504
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3884 - American Art to 1914 (3 credits)
American art and material culture from Pre-Columbian past to the early 20th century. A chronological study of the major artists, artistic movements, and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ART 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3954B - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3984 - Special Study (19 credits)
Instructional Contact Hours: (19 Lec, 19 Crd)

ART 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCI 4014, HIST 4014

ART 4104 - Interpretation of Visual Arts (3 credits)
Capstone seminar for the Pathways Minor in the Visual Arts and Society. Introduces methodologies, theories, and interpretive strategies commonly used to analyze the visual arts and architecture. Focuses on various critical case studies of global objects and sites ranging from the prehistoric to contemporary periods in the fields of: painting, sculpture, architecture, photography, and film. Assignments explore regional arts resources in these media and develop discursive skills employed in written and oral presentations. Considers ethical and political issues surrounding interpretation of art, as well as attendant epistemological challenges. Pre: Six credits of social sciences from Pathways Minor in the Visual Arts and Society checksheet.
Prerequisite(s): ART 1104
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4184 - Museum Studies: Theory and Practice (3 credits)
Examines the history, theory and practice of museums. Explores the role of the museum in society and traces the foundations upon which these public, cultural, and educational institutions are built. Focus on contemporary museum management, administration, interpretation, collection policy, as well as how museums pertain to historic preservation and public cultural exhibitions.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4284 - Museum Ethics and Cultural Preservation (3 credits)
Advanced art history elective. Role of ethics in institutions that preserve cultural heritage. Practical and philosophical dilemmas and controversies relevant to contemporary problems in cultural preservation. Ethical challenges of governance, acquisition, collecting, audience, copyright, conservation, the politics of display, and censorship, among current topics.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4384 - Topics in Art History (3 credits)
Advanced art history elective. Rotating topics from all periods of art history, selected to complement offerings at the 3000-level. Topics such as Greek Sculpture, Roman Painting, Renaissance and Baroque Sculpture, Cubism, and Fauvism indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit for a maximum of 18 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 18 credit hours

ART 4484 - Topics in Art Criticism and Methodology (3 credits)
Advanced art history elective. Rotating topics in the criticism of art and the methodology of art history and criticism, selected to complement offerings at the 3000-level. Topics such as the History of Art Criticism from Baudelaire to the Present, New Methods in Renaissance and Baroque Art History, and the Theory of Art from various periods, indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit with different content to a maximum of 9 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 4504 - Topics in Multimedia Studio (3 credits)
This studio course investigates computer-based multimedia in the visual arts and applied design. Video, photography, computer art and design may be used with traditional media and communication vehicles. May be repeated for a maximum of 9 credits. Two 3000-level courses required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2576 or ART 2604 or ART 3564
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4514 - Interarts Studio (3 credits)
This studio course will investigate new approaches to art-making and new genres, such as performance art and site-specific installation. Interdisciplinary basis for course may incorporate traditional studio practices and media in the visual arts, music and theatre arts, and appropriate technology in computer, video, and film. May be repeated for a maximum of 12 credits with different topics. 3000-level course in Studio or Art History or departmental approval. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 4524 - Pictorial Arts Studio (3 credits)
Rotating topics in the two dimensional arts, at an advanced level. All topics will challenge the student to develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Painting or Drawing course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3524 or ART 3514
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4534 - Topics in Applied Art and Design Studio (3 credits)
Rotating topics about functional art and design. Students will use appropriate materials, tools, and processes in the creation of functional artworks, such as furniture, tiles, tableware, etc. Function and design aesthetics emphasized. May be repeated for a maximum of 9 credits with different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3544
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4544 - Computer Animation Studio (3 credits)
Advanced animation course focusing on the creation of short films, demo reels, and expressive computer animated films. Students enrolled in this course are expected to complete one large project during the semester. May be repeated with different course content for up to nine credit hours. Course contact to credit hour structure: Design Lab/Studio (5L, 3C)
Prerequisite(s): ART 3704
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4554 - Spatial Arts Studio (3 credits)
Advanced level, rotating topics in the three dimensional arts. All topics will challenge the student to develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Ceramics, Sculpture or Applied Art course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3554
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4564 - Exhibition Design And Display (3 credits)
This course will focus on the display and presentation of visual art, for student-designed exhibitions. Provides experience in the public art arena, and practical k arena, and practical knowledge about planning, designing, and mounting an exhibition. Pre: 3000-level Studio or Art History course required.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4574 - Advanced Visual Communications (3 credits)
A further refinement of design theory and practice, and communication skills. Emphasis on the conceptual development of expanded project formats, and individual creativity. This class will provide a principal opportunity for building a viable portfolio. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE 6 credits of Art 3574 required.
Prerequisite(s): ART 4504
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4575 - Advanced Visual Communication Design (3 credits)
Refinement of design theory, practice, and communication skills. Emphasis placed on methodologies and strategies for developing a personal identity, website, and/or multimedia portfolio. Development of professional brand identity through web design, design of business cards, letterhead, envelopes, and electronic media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565 and ART 3566 and ART 4584
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4576 - Advanced Visual Communication Design (3 credits)
Refinement of design theory, practice, and communication skills. Emphasis placed on methodologies and strategies for developing a personal identity, website, and/or multimedia portfolio. Development of professional brand identity through web design, design of business cards, letterhead, and electronic media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565 and ART 3566 and ART 4584 and ART 4575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4584 - Advanced Typography (3 credits)
Advanced study of Typography as it relates to Visual Communication Design including historical and contemporary context. Terminology and advanced applications of Typography, complex grid systems, experimental typographic methods, and material studies. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4684 - Topics in Museums and Collections (3 credits)
Advanced art history elective. Variable topics related to the study of museums and collections from a global perspective. Topics such as the Natural History Museum, Introduction to Curatorial Studies, Conservation and Collections Management, Race and Colonialism in Museum Exhibitions, and Censorship in Cultural Institutions, indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated 2 times with different content for a maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4804 - New Media Art Theory (3 credits)
Exploration of new media theory in relationship to contemporary arts practice. Overview and application of new media art aesthetics, strategies, trends, and socio-cultural aspirations. The course will examine theoretical writings and creative work from prevailing technologically-based disciplines.
Prerequisite(s): ART 2385 and ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4894 - Senior Studio (3 credits)
Preparation and presentation of concentrated studio work under faculty supervision, culminating in solo exhibition and/or formal portfolio. May be extended over two semesters with final grade assigned on completion. Or may be repeated for a total of 6 credits at a maximum of 3H, 3C per semester. Senior standing and consent of department head required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ART 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Behavioral Decision Science (BDS)

BDS 2005 - Fundamentals of Behavioral Decision Science (3 credits)
Introduction to the major scientific models of decision making and applications to real-life situations. Economic models highlighting optimal choices and psychological models highlighting decision making tendencies. 2005: Emphasis on individual decision making in non-strategic choice settings. Probabilistic reasoning and economic model of rationality. Violations of the rational choice model, and psychological, physiological, and statistical models that accommodate this behavior. Applications to social settings and longer periods of time. Common ethical dilemmas and making ethical choices as an individual. 2006: Individual decision making in interactive and strategic choice settings as well as group decision making. Simultaneous, sequential, dynamic, repeated, and incomplete information games. Preferences for fairness, reciprocity, and cultural differences in interactions. Limitations when making group decisions. Ethical reasoning and computational analysis of strategy. Applications to voting, negotiations, and cooperation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BDS 2006 - Fundamentals of Behavioral Decision Science (3 credits)
Introduction to the major scientific models of decision making and applications to real-life situations. Economic models highlighting optimal choices and psychological models highlighting decision making tendencies. 2005: Emphasis on individual decision making in non-strategic choice settings. Probabilistic reasoning and economic model of rationality. Violations of the rational choice model, and psychological, physiological, and statistical models that accommodate this behavior. Applications to social settings and longer periods of time. Common ethical dilemmas and making ethical choices as an individual. 2006: Individual decision making in interactive and strategic choice settings as well as group decision making. Simultaneous, sequential, dynamic, repeated, and incomplete information games. Preferences for fairness, reciprocity, and cultural differences in interactions. Limitations when making group decisions. Ethical reasoning and computational analysis of strategy. Applications to voting, negotiations, and cooperation.
Prerequisite(s): BDS 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BDS 3134 - Choice and Behavior (3 credits)
Theories of rational choice, utility, and revealed preference. Intertemporal decision problems and choice under uncertainty with applications to insurance and investments. Behavioral regularities and evidence of violations of rational choice theory. Behavioral models that accommodate this behavior. Applications of behavioral models to economic problems, ethical questions, policy, and organization design. Pre: Sophomore standing.
Prerequisite(s): ECON 2005 or BDS 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3134

BDS 4184 - The Science of Giving (3 credits)
Overview of the science of giving, altruism, helping, cooperation, and prosocial behaviors and decision making. Exploration of the personality contextual, cognitive, and affective factors that move people to help others in need. Application of psychological and behavioral principles necessary to craft interventions such as nudges to increase giving with emphasis on public policy. Methodological issues related to laboratory and field experiments. Ethical considerations in persuasion and influence.
Prerequisite(s): PSYC 1094 or HD 3014 or SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 4184

BDS 4194 - Predicting Social Behavior (3 credits)
Overview of the process of predicting human choices, preferences, and actions in social contexts. Applications of measurement theory to data preparation, formatting, and scaling. Implications of psychological biases for data transformation and cleaning. Theory-guided predictor variable selection and development. Applications of machine learning to social settings. Evaluating prediction quality, bias, and generalizability. Developing predictive models in software. Ethical and societal implications of predicting human behavior.
Prerequisite(s): (PSYC 1094 or ECON 3254) and (BIT 2405 or STAT 2004 or STAT 3604 or STAT 3005 or STAT 3615)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 4194

BDS 4864 - Developing Behavioral Science Policies and Interventions (3 credits)
Senior-level capstone course to apply theories and models from behavioral decision science to real world problems on topics from education, organizations, health, crime, environment, and volunteerism. Utilize behavioral science theories, data and analytical frameworks from research papers to define and analyze problems or unintended consequences resulting from individual decision-making. Emphasis on identifying specific problems, formulating behavioral policies or interventions to improve performance, and designing experiments and randomized controlled trials to test their effectiveness.
Prerequisite(s): BDS 3134 or ECON 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4864

Biochemistry (BCHM)

BCHM 1014 - Biochemistry First Year Experience (1 credit)
Academic and career planning for biochemistry majors and students considering biochemistry as a major. Topics discussed: academic success, careers, diversity and inclusion, graduate school, professional health opportunities, library resources, wellness, undergraduate research, internships, study abroad, and service-learning opportunities. Introduction to biochemistry discipline and faculty. Development of a comprehensive academic plan of study and opportunity for self-awareness/reflection.
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 1024 - Introductory Experience in Biochemistry Research Skills (1 credit)
Introduction of foundational knowledge on the central tenets of biochemistry and research skills. Development of critical thinking skills and professional development through networks. Collection, analysis, and interpretation of data. Evaluation of literature, use of citation management programs, and development of scientific writing and presentation skills. Data management, visualization, and ethics in the context of biochemistry. Emphasis on teamwork, literature reading, and scientific communication skills.
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2024 - Concepts of Biochemistry (3 credits)
Short course in fundamentals of the chemistry of living systems. Introduction to major categories of biochemical substances, metabolic pathways, and principles of biochemical information transfer. (No credit for majors).
Prerequisite(s): CHEM 2514 or CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 2114 - Biochemical Calculations (2 credits)
Fundamental mathematical relationships in biochemistry. Calculations central to the investigation of biochemical phenomena including aqueous chemistry, spectrophotometry, enzyme kinetics and thermodynamics. Introduction to the core calculations used in experimental biochemistry and the strategies employed for solving biochemical problems.
Prerequisite(s): CHEM 2535 or CHEM 2565
Instructional Contact Hours: (2 Lec, 2 Crd)

BCHM 2354 - Biochemical Techniques (3 credits)
Fundamental aspects of biochemical laboratory measurements. Properties of biomolecules and methods for their isolation, separation, detection and quantification. Calculations required to provide quantitative biomolecular data. Common instrumentation in biochemical laboratories, their principles of operation, and their roles in biochemical assays and measuring biochemical interactions. Overview of on-line resources for biochemical information.
Prerequisite(s): CHEM 2514 or CHEM 2535 or CHEM 2565
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 2364 - Biochemical Techniques Laboratory (1 credit)
Operation of key equipment found in a biochemistry/molecular biology laboratory (e.g., enzyme kinetics, PCR); analyzes, interpretation and presentation of data acquired in laboratory-based protocols; report of results of experiments; use of laboratory automation for biochemical measurements.
Corequisite(s): BCHM 2354
Instructional Contact Hours: (3 Lab, 1 Crd)

BCHM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BCHM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 3114 - Biochemistry for Biotechnology and the Life Sciences (3 credits)
Survey presentation of the basic principles of biochemistry as they apply to biotechnology. Topics covered include protein structure, enzymology, cellular organization, and biochemical regulation. Special emphasis will be given to gene structure, transcription, and translation, cellular organization, and cloning, sequencing, modification and expression of recombinant DNA. Examples will be given of agricultural/medical/industrial applications of cellular and molecular biochemical knowledge. Non-majors only.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 3634 - Analysis of Biochemical Literature (3 credits)
Analysis of primary scientific literature using recently published biochemical research articles. Application of the CREATE model (Consider, Read, Elucidate and generate a hypothesis, Analyze and interpret the data, and Think of next Experiment) as a conceptual framework. Evaluation of article data, limitations and broader impacts. Impact of scientific philosophy, experimental design, and peer review in scientific research and publishing. Pre: Junior standing.
Prerequisite(s): (BIOL 2134 or BIOL 2604) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

BCHM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4054 - Genomics (3 credits)
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized.
Prerequisite(s): BCHM 3114 or BCHM 4116 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 4054

BCHM 4074 - Career Orientation (1 credit)
Examination of various career opportunities for biochemists in industry, academia, medicine and related health sciences. Introduction to resources for locating career opportunities, resume preparation and interview skills. Restricted to biochemistry majors. Junior standing required. I
Corequisite(s): BCHM 4115
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 4115 - General Biochemistry (4 credits)
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115).
Prerequisite(s): (CHEM 2536 or CHEM 2566) and (BCHM 2114 or CHEM 2154)
Instructional Contact Hours: (4 Lec, 4 Crd)

BCHM 4116 - General Biochemistry (3 credits)
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115). I,II
Prerequisite(s): BCHM 4115
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4124 - Laboratory Problems in Biochemistry and Molecular Biology (6 credits)
Presentation of major analytical techniques of importance to biochemistry and molecular biology, including spectrophotometry, electrophoresis, chromatography. Lab study of selected principles and methods used in biochemistry and molecular biology.
Prerequisite(s): BCHM 4115 and (CHEM 2114 and CHEM 2124) or (CHEM 3114 and CHEM 3124)
Corequisite(s): BCHM 4116
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

BCHM 4354 - Biochemical Communication (3 credits)
Exploration of how chemical signals are produced, transported, and influence microbes (Bacterial and unicellular organism (chemotaxis), plants, and animals (olfactory neuroethology). Applications to cell biology, neurobiology, and ecology. Analysis of the interaction between biochemical communication systems and health (diseases). Management, statistical analysis, and interpretation of large datasets related to biochemical communication, using computational approaches.
Prerequisite(s): (BCHM 3114 or BCHM 4115) and (STAT 2004 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4554 - Biophysics for Biochemistry (3 credits)
Thermodynamics, quantum mechanics, and statistical mechanics in biological systems, with emphasis on theoretical understanding of experimental biophysical methods. Fundamental concepts in protein and nucleic acid folding, dynamics from bond vibrations to kinetics and diffusion, molecular orbital theory, protein-ligand interactions and associated molecular visualization tools. Computational modeling, calculations, and simulation using both quantum and classical mechanics.
Prerequisite(s): BCHM 3114 or BCHM 4115
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4784 - Applications in Molecular Life Science (3 credits)
Synthesis and application of biochemistry, cell biology, genetics, genomics, physiology, immunology concepts and techniques to address medical and agricultural problems. Gene characterization and manipulation, protein-based drugs, diagnostics, vaccines, transgenic plants/animals. Analysis, critique, application of research in molecular life science.
Prerequisite(s): (BCHM 3114 and BCHM 3124 and BIOL 3774 and BIOL 4774) or (BCHM 4116 and BCHM 4124)
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BCHM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Biological Sciences (BIOL)

BIOL 1004 - Biology Orientation Seminar (1 credit)
An introduction to academic and career planning for majors in Biology and students who may be considering Biology as a major.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1014 - Introduction to Biology (3 credits)
Introductory biology for non-life science majors. Topics covered include the hierarchy of living systems, cell structure, physiology, and reproduction, Mendelian genetics, molecular genetics, evolution, microbial diversity, plant anatomy and physiology, animal anatomy and physiology, and ecological systems. Ethical aspects of current research in these areas. Partially duplicates 1005, 1006, 1105, 1106.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1024 - Cancer: Causes, Treatments, Costs (3 credits)
Introduction to risk factors and biological mechanisms associated with cancer. Current approaches to cancer prevention, diagnosis, and treatment. Personal, socioeconomic, and global aspects of cancer.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1034 - Biology of Sex (3 credits)
Sexual reproduction in living organisms from a scientific perspective including morphology, physiology, behavior, development and evolution. Biological basis and ethical considerations of human societal issues including contraception, homosexuality, and gender/sex.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1054 - Human Biology: Concepts and Current Issues (3 credits)
Survey of human biology, including physiology, genetics, evolution, and ecology. Focus on homeostasis, including factors and choices that disrupt homeostasis and health. Examination of technological advances and ethical issues associated with the biology of humans. Personal and societal choices that impact human ecology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1064 - Plants and Civilization (3 credits)
Survey of basic plant biology. Critical roles of plants as food, drugs, textiles, other products. Examination of the global, historical, and cultural links between plants and humans. Discussion of current topics, including biotechnology, global change, biodiversity loss, nutrition and drug addiction.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1074 - How Animals Think (3 credits)
Overview of scientific research on animal cognition and behavior from perspectives in biology, psychology, and neuroscience. Study and application of scientific approaches to the study of animal cognition and behavior in the context of personal, political, and societal decision making. Considers the influence of animal cognition and animal ethics on decisions about human-animal interactions at a personal and societal scale ranging from decisions about food supply to conservation. Provides the framework to evaluate animal personality, emotion, consciousness, and rights. Addresses how cultural, social and political views influence scientific research on animal cognition. Consideration of bidirectional effects of human-animal interactions on One Health and animal welfare.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1105 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014)
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1106 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014).
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1115 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences. (Duplicates 1015 1016, 1125, 1126).
Corequisite(s): BIOL 1105
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1116 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences.
Corequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1135 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1136 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Prerequisite(s): BIOL 1135
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1214 - Careers in Medicine (1 credit)
For students considering a career in health care. Investigation of various health care professions, including requirements for additional education and the professional and personal expectations characteristic of these professions. Introduction to biomedical ethics and health policy. Options for financing professional school. How to become a competitive applicant.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2004 - Genetics (3 credits)
Mendelian transmission, chromosome behavior and organization, gene and chromosome mutation, genetic properties of nucleic acids, gene expression and development, DNA technology.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or CHEM 1016 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2124 - Cell and Molecular Biology for Engineers (2 credits)
Composition, structure and function of cells; fundamentals of gene expressions, cell physiology, cellular movement and reproduction; stem cells and tissue formation; synthetic biology and applied cell and molecular biology. Not for Biological Sciences majors.
Prerequisite(s): ENGR 2164 or COS 2164
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 2134 - Cell Function and Differentiation (3 credits)
Fundamental mechanisms essential for cell function. Methods used to study cells. Cellular structure and physiology, energy production, cell survival and reproduction. Cell interactions and communication, stem cells, cell differentiation, tissue formation.
Prerequisite(s): BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 2304

BIOL 2404 - Biotechnology in A Global Society (3 credits)
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H) and CHEM 1015 and CHEM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 2404

BIOL 2504 - General Zoology (3 credits)
Morphology, features, adaptations, and ecology of major animal groups, emphasizing major patterns of evolutionary change.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2604 - General Microbiology (3 credits)
Microbial structure, function, metabolism, genetics and ecology. The role of microorganisms in host/parasite relationships will be emphasized.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2614 - General Microbiology Laboratory (1-2 credits)
Introduction to microbiological techniques and procedures. Aseptic technique and safe handling. Culture, characterization, and identification of microorganisms.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Corequisite(s): BIOL 2604
Instructional Contact Hours: (2-4 Lab, 1-2 Crd)

BIOL 2704 - Evolutionary Biology (3 credits)
Evolutionary mechanisms, systematic principles, and theories of the origin and evolution of life.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2804 - Ecology (3 credits)
Fundamental interaction of organisms with the biotic and abiotic components of ecosystems. Topics will include: physical environment and organismic interactions, concepts of population ecology and community ecology, ecosystems interactions, and environmental problems.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2984D - Special Study (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

BIOL 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 3014 - Insect Biology (2 credits)
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: ENT 3014

BIOL 3024 - Insect Biology Laboratory (2 credits)
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3014
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: ENT 3024

BIOL 3104 - Cell and Molecular Biology Laboratory (1 credit)
Introduction to methods used to study prokaryotic and eukaryotic cells. Recombinant DNA, protein expression and purification, the polymerase chain reaction, bioinformatics, and microscopy.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 3134 - Human Genetics (3 credits)
Principles of genetic analysis in humans with emphasis on genetic diseases of humans; methods of karyotyping human chromosomes; methods of pedigree and genetic analysis of humans; principles, techniques, and analysis of twin studies in humans; techniques used to identify and characterize normal and abnormal chromosomes; principles and methods of DNA fingerprint analysis of humans.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3204 - Plant Taxonomy (3 credits)
Systematic survey of vascular plants, emphasizing identification, terminology, classification, evolutionary relationships.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3254 - Medical and Veterinary Entomology (3 credits)
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENT 3254

BIOL 3264 - Medical and Veterinary Entomology Laboratory (1 credit)
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group.
Prerequisite(s): (BIOL 1105 and BIOL 1106) or (BIOL 1005 and BIOL 1006) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3254
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ENT 3264

BIOL 3404 - Introductory Animal Physiology (3 credits)
A comparative systems level approach to the physiology of animals, emphasizing vertebrates: metabolic, temperature, osmotic, and ionic regulation; function of respiratory, circulatory, digestive, muscle, nervous, and locomotory systems; endocrine regulation and biological rhythms. Must have prerequisites or instructors permission.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3454 - Introductory Parasitology (4 credits)
Ecology, taxonomy, morphology, life cycles, pathogenesis, and host-parasite relationships of parasitic eukaryotes.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 3514 - Introduction to Histology (3 credits)
Overview of tissue structure and function in the human body; microscopic examination of tissue sections; organization of tissues in different organ systems; histopathology of tissues and organs.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3604 - Food Microbiology (4 credits)
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Methods to enumerate, identify, and characterize microorganisms in foods.
Prerequisite(s): BIOL 2604 and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: FST 3604

BIOL 3764 - Careers in Microbiology (3 credits)
Contemporary research topics in microbiology, methods of research data analysis, the research publication process, research presentation and interview skills, career paths for microbiology graduates, preparation for graduate school, preparation for entry into the job market.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3774 - Molecular Biology (3 credits)
Advanced study of the molecular biology of prokaryotic and eukaryotic cells, including mechanisms of gene expression and regulation, relative merits of experimental model systems, and practical applications in agriculture and medicine.
Prerequisite(s): BIOL 2134 or ALS 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3804 - Principles of Biology Teaching Assistant (2 credits)
For undergraduate teaching assistants (UTAs) facilitating BIOL 1105 or 1106 class sections that utilize active-learning pedagogies and require facilitation of in-class learning activities. Content and practice of teaching strategies and professionalism in the classroom. Supervision by departmental faculty or staff. Selection by Principles of Biology instructional team. May be repeated four times with different content for a maximum of eight credits. Junior Standing, overall minimum GPA of 3.0.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (6 Lab, 2 Crd)
Repeatability: up to 8 credit hours

BIOL 3814 - Careers In Biological Sciences (1 credit)
Exploration of career opportunities in the biological sciences, including employment and further education. Professional development activities, including resumes, career fairs, networking, preparation for interviews, ethics, and assessment and comparison of job offers. Does not count for Biological Sciences or Microbiology elective credit. Pre: junior standing
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 3954 - Study Abroad (1-6 credits)
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

BIOL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4004 - Freshwater Ecology (4 credits)
Interactions of physical, chemical, and biological properties of freshwater ecosystems.
Prerequisite(s): BIOL 2804 or BIOL 2804H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4014 - Environmental Toxicology (2 credits)
Discussion of ecotoxicological and philosophical issues in the development of standards for control of toxic chemicals in freshwater, including site-specific examples, application of current control methods, recovery of damaged ecosystems, and government regulations.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 4104 - Developmental Biology (3 credits)
Morphological, physiological, and molecular events in embryological and developmental systems, including regulation at the level of transcription, translation, and enzyme or hormone activation.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4114 - Global Change Ecology (3 credits)
Effects of human alteration of climate, landscapes and biogeochemical cycling on ecological structure and functioning at the global scale. Influence of global changes on ecosystem processes and biodiversity with paleo- and contemporary examples. Current and future potential feedbacks between biological systems and the global environment.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4134 - Evolutionary Genetics (3 credits)
Genetic variation, Hardy-Weinberg equilibrium, agents of change in gene frequencies, molecular evolution, mechanisms of speciation. Comparison of theoretical models with natural and laboratory populations.
Prerequisite(s): BIOL 2004 and (BIOL 2704 or BIOL 2704H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENSC 4164

BIOL 4204 - Advanced Principles of Biology Teaching Assistant (3 credits)
For experienced Principles of Biology Undergraduate Teaching Assistants (UTAs) facilitating instruction of BIOL 1105 or 1106 class sections that utilize active-learning strategies. Collaboratively plan, present, and run activities to train first-time UTAs in the skills needed to support student success in the Principles of Biology classroom. Prepare first-time UTAs to guide active learning exercises, facilitate student teamwork, communicate scientific information, respond to student questions, provide feedback on student activities, and promote student engagement. Model professional and ethical conduct. Enrollment requires approval of Principles of Biology instructional team. May be repeated three times with different content for a maximum of nine credits. Pre: Senior standing.
Prerequisite(s): BIOL 3804
Instructional Contact Hours: (9 Lab, 3 Crd)
Repeatability: up to 9 credit hours

BIOL 4314 - Plant Ecology (4 credits)
Introduction to ecology of terrestrial plants including major plant functional types, ecophysiological aspects of functional types, molecular plant ecology, behavior of populations, responses of plant communities to disturbance, and vegetation analysis. Laboratory covers methods for measuring and analyzing natural vegetation, and setting up field and greenhouse experiments.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 3314) or HORT 2304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4334 - Chemical Ecology (3 credits)
Chemical interactions between organisms with emphasis on the plant biosphere. Fundamental concepts, theories, and general methodology of chemical ecology: mechanisms of chemically- mediated interactions; and engineering of natural chemical defenses in sustainable agriculture.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 2314 or BCHM 4115) and CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4354 - Aquatic Entomology (4 credits)
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organisms in aquatic ecology, pollution monitoring, and natural resource management.
Prerequisite(s): (BIOL 1005 and BIOL 1006) and (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106 and BIOL 1115 and BIOL 1116)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4354

BIOL 4404 - Ornithology (4 credits)
Biology of birds, including functional anatomy, systematics, evolutionary history, behavior, and ecology. Laboratory on systematics, anatomy, and field experience in the areas of behavior and ecology.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4454 - Invertebrate Zoology (4 credits)
Identification, morphology, evolutionary relationships, and natural history of free-living invertebrates, excluding insects.
Prerequisite(s): BIOL 2504
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4474 - Ethology (3 credits)
An evolutionary and ecological approach to animal behavior, drawing on behavioral genetics, endocrinology, neurophysiology, and behavioral ecology to explain how and why the behavior of an organism is adapted to its environment.
Prerequisite(s): BIOL 2504
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4484, FIW 4484

BIOL 4554 - Neurochemical Regulation (3 credits)
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet.
Prerequisite(s): (ALS 2304 or BIOL 3404) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4554

BIOL 4564 - Infectious Disease Ecology (3 credits)
Principles of infectious disease dynamics from ecological and evolutionary perspectives. Examines a variety of wildlife hosts and disease-causing agents (bacteria, viruses, and parasites) using the framework of agent-host- environment interactions. Selective coverage of specific host and pathogen models to illustrate underlying principles of wildlife disease emergence, maintenance, and spread, as well as connections between wildlife and human health.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and (BIOL 2804 or BIOL 2804H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4574 - Social Behavior of Birds and Mammals (3 credits)
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural companion and laboratory settings are discussed.
Prerequisite(s): BIOL 1106 and ALS 3104 or BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4574

BIOL 4594 - Ecology, Evolution, and Behavior Senior Seminar (3 credits)
Review and discussion of contemporary research areas and global challenges addressed in publications in ecology, evolution, and behavior, the research process, methods for communicating science to professional and non-professional audiences, professional development for careers in ecology, evolution, and behavior, diversity and equity in the sciences.
Prerequisite(s): BIOL 2704 and BIOL 2804
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4624 - Microbial Genetics (3 credits)
Molecular genetics of bacteria and their associated plasmids and phages.
Prerequisite(s): BIOL 2004 and (BIOL 2604 or BIOL 2604H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4634 - Microbial Physiology (3 credits)
The study of the structure, function and metabolic activities of prokaryotic microorganisms. Topics covered included cell composition and growth, metabolic unity and diversity, patterns of regulation, transport mechanisms, environmental sensing and response and cellular differentiation processes. (BIOL 4624 is recommended, but not required.)
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4644 - Microbial Molecular Genetics and Physiology Laboratory (3 credits)
Introduction to classical and molecular methods used for the study of bacterial genetics and physiology. Laboratory exercises cover analysis of patterns of gene regulation; assay of enzymatic activities; mutagenesis followed by selection, screening, and physiological characterization of mutant strains; genome database utilization; and large scale fermentation.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4664 - Virology (3 credits)
Classification, structure, pathogenesis, host response, and replication strategies of viruses of bacteria, plants, and animals, stressing mechanisms elucidated by molecular biological techniques.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

BIOL 4674 - Pathogenic Bacteriology (3 credits)
Characteristics of bacteria that cause human disease, nature of infectious processes, virulence factors, epidemiology, resistance, immunization.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4684 - Microbiomes (3 credits)
Landmark and current research on human microbiomes. Factors that influence the gut microbiome, and the role of the gut microbiome in disease. Other microbiomes of the human body. Bacteriophages and the ecology of microbiomes. Application of technologies to engineer microbiomes.
Prerequisite(s): BIOL 2004 and BIOL 2604 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4704 - Immunology (3 credits)
Immunochemistry of antigens and antibodies, serological reactions, chemistry of complement, control of immunity, immune response of an intact animal.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4714 - Immunology Laboratory (1 credit)
Serological and immunobiological techniques used to interpret the consequences of an immune response.
Prerequisite(s): BIOL 2134
Corequisite(s): BIOL 4704
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 4724 - Pathogenic Bacteriology Lab (2 credits)
Microbiological techniques used to identify and characterize bacteria that cause infectious disease.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Corequisite(s): BIOL 4674
Instructional Contact Hours: (4 Lab, 2 Crd)

BIOL 4734 - Inflammation Biology (3 credits)
Cellular and molecular pathways controlling human responses to inflammatory challenges. Regulation of immune cells during inflammation. Interaction of host cells and tissues with environmental risk factors that cause inflammation. Pathogenesis of inflammatory diseases including cardiovascular diseases, diabetes, multi-organ failure, aging, neurological diseases and sepsis. Therapeutic intervention of inflammatory diseases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4774 - Molecular Biology Lab (3 credits)
An introduction to recombinant DNA methods, including restriction endonuclease digestion, gel electrophoresis, cloning, Southern blotting, polymerase chain reaction, sequencing and analysis of reporter gene expression in transgenic organisms. BIOL 3774 may be taken as a corequisite with 4774.
Prerequisite(s): BIOL 3774
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4804 - Prokaryotic Diversity (3 credits)
The study of the vast array of physiological, morphological, and behavioral properties of prokaryotes. Topics include: modern prokaryotic classification, prokaryotic diversity, relationship and importance to cell and molecular biology and biochemistry, application and use in industry and agriculture, and to the maintenance of the biosphere. Must have pre-requisites or consent of the instructor.
Prerequisite(s): (BIOL 2604 or BIOL 2604H) and BIOL 2614 and (BIOL 3124 or BIOL 4634 or BCHM 3114)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4824 - Bioinformatics Methods (3 credits)
Application of bioinformatics methods in biological research. Methods to access bioinformatics data. Theory and methods for analysis of DNA sequences, and analysis of complex data sets including whole genome sequences and gene expression data. Use of standard bioinformatics software and databases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4834 - Practical Analysis of Protein Structure and Function (3 credits)
Application of biophysical and biomechanical methods to characterization of protein structure and function, macromolecular interactions and conformational changes. Strategies, experimental design, practical considerations, troubleshooting, data analysis.
Prerequisite(s): BIOL 2134 and (CHEM 2536 or CHEM 2566) and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4844 - Proteomics and Biological Mass Spectrometry (3 credits)
Introduction to mass spectrometry (MS) instrumentation and advanced proteomic methods for systems biology applications. Peptide mass fingerprinting, tandem MS, quantitation, phospho/glyco proteomics, and bioinformatics tools for evaluation and interpretation of mass spectrometry data.
Prerequisite(s): BIOL 2134 and CHEM 2535 and PHYS 2205
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4854 - Cytogenetics (3 credits)
Structure and function of eukaryotic chromosomes, with emphasis on (i) use of model systems to study specific chromosome substructures or functions; (ii) techniques used to identify and classify both normal and aberrant chromosomes; and (iii) diseases caused by defective chromosome structure and/or function.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4864 - Clinical Biology (3 credits)
Biological basis, development and symptoms of selected human diseases. Pharmacological approaches to treating disease. Review and interpretation of clinical cases. Approaches to working with patients: the interview, physical examination and clinical history. Use of diagnostic tests and treatments. Clinical trials of potential therapeutic interventions.
Prerequisite(s): BIOL 2134 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4874 - Cancer Biology (3 credits)
The molecular and cellular basis of cancer, including viral and cellular oncogenes, tumor suppression mechanics, cellular immortality, genomic integrity, angiogenesis, metastasis, and traditional and developing therapies.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4884 - Cell Biology (3 credits)
Advanced study of the inner workings of eukaryotic cells, including membrane structure and function, protein secretion, the cytoskeleton, cell cycle control and intercellular communication.
Prerequisite(s): BIOL 3774 or BCHM 4116
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 29844 - Special Study (1-18 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: (1-18 Lec, 1-18 Crd)

Biological Systems Engineering (BSE)

BSE 1004 - Engineering Biological Systems for the Global Good (1 credit)
Survey of global societal and technological issues that engage biological systems engineers in the areas of health, environment, food and energy. Application of systems-level approaches to meet engineering challenges that intersect with crucial societal issues, including sustainability and equity. Evaluation of key factors that affect the design, communication, and public acceptance of engineered solutions. Analysis of cultural intelligence, with a specific focus on personality and problem solving styles amongst individuals and teams and productive conflict resolution.
Instructional Contact Hours: (1 Lec, 1 Crd)

BSE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2004 - Introduction to Biological Systems Engineering (3 credits)
Introduction to the fundamental concepts of Biological Systems Engineering, including statistics and material and energy balances, through applications in protein separation, hydrology, sediment/nutrient transport, and microbial metabolism. Engineering design process. Engineering problem-solving tools and techniques. Resolving ethical dilemmas. Development of oral and written communication skills; introduction to job searching resources; strategies for career development, and the importance of teamwork and ethics in Biological Systems Engineering.
Prerequisite(s): ENGE 1215 or ENGE 1414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2304 - Landscape Measurements and Modeling (3 credits)
Introduction to land surveying, computer-aided design, and drafting for land and water resources engineering. Representation of features in two and three dimensions for documentation and visualization of watershed engineering projects. Create plans, cross sections, detail drawings, and three dimensional visualizations using computer-aided design and drafting tools.
Prerequisite(s): MATH 1206 or MATH 1226
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3144 - Engineering Analysis for Biological Systems using Numerical Methods (2 credits)
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. Course requirements may be satisfied by taking MATH 2214 prior to or concurrent with course.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (2 Lec, 2 Crd)

BSE 3154 - Thermodynamics of Biological Systems (3 credits)
Description of biological, chemical and mechanical mechanisms of energy storage and conversion to work. Derivation and use of the first and second laws of thermodynamics (energy and entropy) to analyze processes found in biotechnology, ecological engineering, and living systems. Analysis of thermodynamic cycles and their relevance to biological systems. Introduction of Gibbs energy, equilibrium at specified pH, and calorimetry of biological reactions.
Prerequisite(s): CHEM 1036 and PHYS 2305 and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3324 - Small Watershed Hydrology (3 credits)
Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis.
Prerequisite(s): PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3334 - Nonpoint Source Pollution Assessment and Control (3 credits)
Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control.
Prerequisite(s): BSE 3324
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 3504 - Transport Processes in Biological Systems (3 credits)
Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions.
Prerequisite(s): BSE 3154 and ESM 3024 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3524 - Unit Operations in Biological Systems Engineering (3 credits)
Description of unit operations for processing biological materials including evaporation, drying, gas-liquid separations, adsorption, membrane separation, and mechanical separation.
Prerequisite(s): BSE 3154 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3534 - Bioprocess Engineering (3 credits)
Engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Metabolic pathways leading to products, enzyme kinetics, cell growth kinetics, and analysis of bioreactors and fermenters.
Prerequisite(s): BSE 3154
Corequisite(s): BIOL 2604, BSE 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4125 - Comprehensive Design Project (2 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126: Complete a comprehensive design project using the team approach, test approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 3334 or BSE 3524
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BSE 4126 - Comprehensive Design Project (3 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126 Complete a comprehensive design project using the team approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 4125
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BSE 4204 - Instrumentation for Biological Systems (3 credits)
Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles. Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts.
Prerequisite(s): PHYS 2306 and ESM 3024
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

BSE 4224 - Field Methods in Hydrology (3 credits)
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, dataloggers, water quality sondes. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control.
Prerequisite(s): BSE 3324 or FREC 3104 or WATR 3104 or CEE 3314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4304 - Introduction to Watershed Modeling (3 credits)
Fundamental modeling principles used to quantifywatershed hydrology, energy budgets,and associated ecosystem functions, such asplant dynamics and biogeochemical processes, at scales ranging from soil poresto watersheds. Code development and model integration to simulate watershed hydrologyandnutrient and sediment transport. Model calibration and performance assessment. Data discovery, acquisition, and processing of data relevant to hydrologic/watershed modeling.
Prerequisite(s): BSE 3334
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4324 - Applied Fluvial Geomorphology (3 credits)
Introduction to landscape evolution. Influence of geology and climate on stream form and processes. Fundamental river mechanics and sediment transport. Stream surveying and classification. River system response to changes in hydrology and sediment supply. Interactions between ecosystems and fluvial systems. Human impacts on stream systems.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4344 - Geographic Information Systems for Engineers (3 credits)
Conceptual, technical, and operational aspects of geographic information systems as a tool for storage, analysis, and presentation of spatial information. Focus on engineering applications in resource management, site selection, and network analysis. Laboratory work and senior standing required.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4394 - Water Supply and Sanitation in Developing Countries (3 credits)
Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: Junior or Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4524 - Biological Process Plant Design (3 credits)
Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirements, economic analysis. Process control and instrumentation of bioprocessing plants.
Prerequisite(s): BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4534 - Bioprocess Engineering Lab (1 credit)
Unit operations commonly used in processing biological materials, including filtration, heat transfer, ultrafiltration, crystallization, and protein expression by fermentation, purification by chromatography, and characterization by gel electrophoresis.
Prerequisite(s): BSE 3524 and BSE 3534
Instructional Contact Hours: (3 Lab, 1 Crd)

BSE 4544 - Protein Separation Engineering (3 credits)
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software.
Prerequisite(s): BSE 3504 or CHE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4544

BSE 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4554, HORT 4554, LAR 4554, SPIA 4554

BSE 4564 - Metabolic Engineering (3 credits)
Engineering concepts for analyzing, designing, and modifying metabolic pathways to convert raw materials to food, pharmaceuticals, fuels and chemicals. Cell metabolism, pathway design, bioenergetics, regulatory mechanisms, metabolic modeling, and genetic tools.
Prerequisite(s): BSE 3534 or BCHM 4115 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4604 - Food Process Engineering (3 credits)
Analysis and design of food processing operations including thermal pasteurization and sterilization, freezing, extrusion, texturization, and mechanical separation.
Prerequisite(s): BSE 3504 and BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Biomed & Veterinary Sciences (BMVS)

BMVS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4014 - Animal Domestication and Genetic Resources (1 credit)
Considers the process, history, sociology and geography of animal domestication. Includes behavioral, physiologic and morphological changes incurred by domesticated stocks. Examines genetic variability of domestic species, considers breed groups and uniquely adapted breeds. Considers reasons for erosion of genetic variability and mechanisms to counteract such erosion. International in scope. Pre: senior status or enrollment in veterinary professional curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 4024 - Diseases of Poultry (2 credits)
Biology control and prevention of poultry diseases. Taught alternate years.
Instructional Contact Hours: (2 Lec, 2 Crd)

BMVS 4054 - Laboratory Animal Management (3 credits)
This course involves a study of the principles of laboratory animal science, providing the student with a basic understanding of the laws and regulations governing the care and use of animals, husbandry and surgery of a variety of lab animal species, and variables which can adversely affect animal research. Through formal lectures, discussions, and laboratory sessions, the course is designed to complement graduate studies in biological, biomedical, and life sciences which involve the use of animals in research.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMVS 4074 - Pharmacology (3 credits)
A basic course in the science of pharmacology, intended to provide an understanding of the mechanisms of action and physiological systemic effects of major classes of drugs of biological, agricultural, social, and medical importance. Must have prerequisites or equivalent.
Prerequisite(s): CHEM 2514 or CHEM 2535 or ALS 2304 or BIOL 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4994H - Undergraduate Research (1-19 credits)
Honors section
Instructional Contact Hours: Variable credit course

Biomed Sci & Pathobiology (BMSP)

BMSP 2135 - Human Anatomy & Physiology (3 credits)
Structure and function of the human body for students preparing for professions in the health fields. 2135: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2136: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2135-2136 duplicates BIOL 2405-2406; may not receive credit for both.
Prerequisite(s): (BIOL 1005 or BIOL 1006) or (BIOL 1105 or BIOL 1106) or (BIOL 1205H or BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMSP 2136 - Human Anatomy and Physiology (3 credits)
Structure and function of the human body for students preparing for professions in the health fields. 2135: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2136: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2135-2136 duplicates BIOL 2405-2406; may not receive credit for both.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMSP 2145 - Human Anatomy and Physiology Laboratory (1 credit)
Laboratory exercises investigating the structure and function of the human body for students preparing for professions in the health fields. 2145: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2146: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2145-2146 duplicates BIOL 2414; may not receive credit for both.
Corequisite(s): BMSP 2135
Instructional Contact Hours: (3 Lab, 1 Crd)

BMSP 2146 - Human Anatomy and Physiology Laboratory (1 credit)
Laboratory exercises investigating the structure and function of the human body for students preparing for professions in the health fields. 2145: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2146: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2145-2146 duplicates BIOL 2414; may not receive credit for both.
Corequisite(s): BMSP 2136
Instructional Contact Hours: (3 Lab, 1 Crd)

BMSP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMSP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Biomedical Engr & Sciences (BMES)

BMES 2004 - Concussion Perspectives: Medical, Scientific and Societal Perspectives (3 credits)
Broad, multidisciplinary description of concussion as it relates to variety of fields including: medicine, psychology, injury biomechanics, technology, equipment design, ethics, and law. Concussion modeling, animal models, diagnosis, neurocognitive testing, and treatment. Testing and instrumentation. Research efforts, credibility and conflicts of interest. Ethical considerations in sports, medicine, and science. Legal implications.
Pathway Concept Area(s): 1A Discourse Advanced, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 2014 - Biomedical Engineering Professional Practice (1 credit)
Topics selected to foster professional development of the Biomedical Engineering (BME) student, including training for experiential learning opportunities, such as research, internships, co-ops, and design. Overview of BME specialization and research areas, career pathways, and preparation for interactions with industry, including the regulatory approval process associated with medical device development. Emphasis on teamwork, communication, employment opportunities, the development of a professional portfolio, ethical considerations, additive manufacturing, and engineering documentation using real-world examples and a design sprint/challenges.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMES 2024 - ESTEEMED Program Seminar (1 credit)
Professional development seminar series for National Institutes of Health (NIH) Enhancing Science, Technology, EnginEering, and Math Educational Diversity (ESTEEMED) program scholars. Professional development and construction of professional portfolio. Overview of safety and ethical considerations within biomedical engineering research. Development of scientific literature searching and summarizing skills. Communication skill development of written and oral content. Strategies for mentoring relationships. May be repeated 3 times with different content for a maximum of 4 credit hours. Pre: Only available to students in the ESTEEMED program.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 4 credit hours

BMES 2074 - Computational Methods in Biomedical Engineering (2 credits)
Numerical methods and software applied to biomedical engineering applications. Structured programming and problem solving within programming environment such as MATLAB. Error estimation, root finding, curve fitting, interpolation, solving linear simultaneous equations, numerical differentiation, numerical integration, and numerical solutions to ordinary differential equations.
Prerequisite(s): MATH 1226 and (ENGE 1215 or ENGE 1414)
Corequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (2 Lec, 2 Crd)

BMES 2104 - Introduction to Biomedical Engineering (3 credits)
Identification, exploration, and evaluation of real-world, complex biomedical engineering problems including safety and ethical considerations. Emphasis on critical thinking, problem solving, group skills, and communication related to the field of biomedical engineering. Literature review and experimental design in biomedical engineering research.
Prerequisite(s): (ENGE 1216 or ENGE 1414) and MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 3004 - Helmet Design: Biomechanics to Health & Social Disparities in Sports (3 credits)
Provides a multidisciplinary description of helmet design with applications to all sports. The biomechanical design parameters for helmets are presented in the broader context of health and social disparities. Through reasoning in the social sciences the class investigates how sex and gender roles have shaped sports and their individual helmet design disparities. A critical analysis of equity relative to race and healthcare is analyzed as it pertains to helmets and concussion treatments and outcomes. Demonstrate the interdisciplinary nature of helmet design and how ethical reasoning and social constructs have shaped the industry.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3024 - BME Cell Engineering Laboratory and Design (2 credits)
Principles of cell engineering, experiment design, quantitative alyses. Laboratory notebook keeping, report writing and oral presentation in a team setting. Measurement of biological molecules such as DNA, RNA, and proteins. Assessment of animal cell viability, migration, mechanics and interactions with biomaterials. Identification of cell phenotypes.
Corequisite(s): BIOL 1105, BMES 2104
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BMES 3034 - Bioinstrumentation Laboratory and Design for Living Systems (2 credits)
Principles of biomedical sensors and their usage for experimental design. Collection of biological signals using analog signal amplifiication and filters, biopotentials, digital acquisition, digital filtering and processing. Analysis of physiological signals on living systems with focus on neural, cadiovascular, respiratory, and muscular systems using a group problem solving approach. Instrumental regulation and safety considerations.
Prerequisite(s): BMES 2104 and ECE 3054
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BMES 3114 - Needs Identification in Healthcare (3 credits)
Define open-ended problem statements related to healthcare. Immersive clinical observation and transdisciplinary medical technology innovation. Needs exploration and screening, disease state fundamentals, and evaluation of existing solutions. User-centered research planning, contextual inquiry, data documentation, stakeholder and market analysis, and regulatory and reimbursement basics.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3124 - Introduction to Biomechanics (3 credits)
Basic principles of biomechanics. Basic musculoskeletal anatomy. Application of classical mechanics to biological systems. Emphasis placed on mechanical behavior (stress and strain), structural behavior, motion, and injury tolerance of the human body. Biomechanics of medical devices and implants. Advances in safety equipment used in automotive, military, and sports applications.
Prerequisite(s): BMES 2104 and ESM 2204 and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3134 - Introduction to Biomedical Imaging (3 credits)
Introduction to major biomedical imaging modalities. Emphasis on X-rays, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), ultrasound, and optical imaging. Essential physics and imaging equations of the imaging system. Sources of noise and primary artifacts. Patient safety and clinical application.
Prerequisite(s): BMES 2104 and (MATH 2204 or MATH 2204H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3144 - Biomedical Devices (3 credits)
Design and uses of biomedical devices for diagnosis and therapy of human and animal diseases. Disease eiologies, progression, risk factors, and epidemiology. Tissue, organ, and systems dysfunction and failure and relevance to life stages (pediatric, adolescent, adult, aged). Useful characteristics of engineered materials for device fabrication, including biocompatibility. Gaps between medical needs and current medical devices.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3154 - Biosignal Processing and Classification (3 credits)
Introduction to the concepts and applications of digital signal processing and machine learning on bioinstrumentation signals from physiologic systems. Emphasis on processing techniques for electrocardiogram (ECG), electromyography (EMG), and speech signals. Apply basic machine learning algorithms for diagnostic classification of biosignals.
Prerequisite(s): BMES 2104 and (CS 1044 or CS 1054 or CS 1064 or CS 1114 or ME 2004 or AOE 2074 or ESM 2074 or BSE 3144 or BMES 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3164 - Fundamentals of Regenerative Medicine and Tissue Engineering (3 credits)
Fundamentals of cell biology, physiology, and engineering of regenerative medicine. Techniques and technologies of regenerative medicine and tissue engineering. Biomaterial selection and manufacturing techniques for regenerative medicine and tissue engineering applications. Overview of genetic and immuno- therapies. Design criteria and process from bench to clinical implementation of tissue engineering solutions. Ethical implications in regenerative medicine.
Prerequisite(s): BMES 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3184 - Problem Solving in BME (3 credits)
Computational and analytical approaches to analyzing biological systems and solving biomedical engineering problems. Problem formulation and exploration of problem-solving techniques to validate computational solutions. Self-directed inquiry and team-based approaches that use reverse engineering, user-in-mind design, and engineering software tools.
Prerequisite(s): BMES 2104 and (ESM 2074 or BMES 2074) and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3224 - Automobile Safety (3 credits)
Provides multidisciplinary analysis of automobile safety around the world. Illustration of the details about the invention of the wheel and how various cultures advanced the wheel into carts for transportation. Design process of seatbelt systems, frontal airbag and side airbag systems. Analysis of vehicle design parameters to optimize restraint systems. Analysis of the design challenges of protecting all occupants including men, women, children, elderly and pregnant occupants. Ethical analysis of the history of laws, media, and societal norms around seatbelt use and current distracted drivers using cell phones.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3844 - Computational Neuroscience and Neural Engineering (3 credits)
Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 3844

BMES 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

BMES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4015 - BME Senior Design and Project (3 credits)
4015: Apply biomedical engineering principles to the design of an approved project using the team approach. Develop design and communication skills. Integrate ethical, global and social issues in engineering. 4016: Apply biomedical engineering principles to develop solutions for an approved design project using a team approach. Complete a project resulting in prototype medical device, circuit, or system. Refine design and communication. Integrate ethical, global, environmental and social issues in engineering. Pre: Senior standing for 4015.
Prerequisite(s): BMES 3034 and BMES 3184
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMES 4016 - BME Senior Design and Project (3 credits)
4015: Apply biomedical engineering principles to the design of an approved project using the team approach. Develop design and communication skills. Integrate ethical, global and social issues in engineering. 4016: Apply biomedical engineering principles to develop solutions for an approved design project using a team approach. Complete a project resulting in prototype medical device, circuit, or system. Refine design and communication. Integrate ethical, global, environmental and social issues in engineering. Pre: Senior standing for 4015.
Prerequisite(s): BMES 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMES 4034 - Wearable Bioinstrumentation (3 credits)
Exploration of science, engineering, and data analytics principles behind wearable technology. Non-invasive measurement and assessment of human physiology and behavior. Data processing and analysis of non-invasive biosignals. Data privacy, protection, and ethical considerations of wearable devices.
Prerequisite(s): (CS 1044 or CS 1054 or CS 1064 or CS 1114 or ME 2004 or AOE 2074 or ESM 2074 or BSE 3144 or BMES 2074) and (STAT 3615 or STAT 3704 or STAT 4604) and (ECE 2054 or ECE 3054)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4064 - Introduction to Medical Physiology (3 credits)
An introductory to the principles of medical physiology. Designed primarily for (but not limited to), undergraduate students minoring in biomedical engineering, and other related engineering and physical sciences majors with little or no formal background in biological sciences. Basic principles and concepts of human physiology. Special emphasis on the interactions of human systems biology in their entirety rather than individual genes and pathways. Pre: Junior standing or permission of instructor.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4134 - Global, Societal, and Ethical Considerations in Biomedical Engineering (3 credits)
Overview of contemporary technological advances to improving human health. Comparison of healthcare systems, problems, and existing solutions throughout the developed and developing world. Consideration of legal and ethical issues associated with developing and implementing new medical technologies. Recognition and definition of gaps between medical needs and current methods and therapies between developed and developing countries. Conceptually design a novel technology.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4154 - Commercialization of BME Res (3 credits)
Commercialization process applied to translational research. Regulatory aspects of biomedical engineering products and technologies (e.g. devices, diagnostics, drugs, biologics). Intellectual property, technology transfer processes, clinical trial design, commercialization of university research, modeling of development costs (e.g. cash flow and revenue projections). Small business startup approaches.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4234 - Mechanics of Biological Systems (3 credits)
Anatomy and physiology of biological systems such as cells, tissues, and organs. Experimental techniques for determining the mechanical behavior of biological systems. Simplified mechanics-based mathematical models of biological systems. Specific biological systems include cells, tissues, and organs of the musculoskeletal, cardiovascular, integumentary system, and reproductive systems.
Prerequisite(s): ESM 2204 and MATH 2214 and MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4234

BMES 4574 - Biomaterials (3 credits)
Materials for biomedical applications. Basic material types and properties, functional uses of materials in medical applications, and tissue response mechanisms. Integrated design issues of multicomponent material design in prosthetic devices for hard and soft tissues, orthopedics , cardiovascular, and drug delivery applications.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 4574

BMES 4614 - Probability-Based Modeling, Analysis, and Assessment (3 credits)
Uncertainty analysis of engineering data, parameters estimation, probability concepts, random variables, functions of random variables, probability-based performance functions and failure modes, risk and reliability functions, probability of failure and safety index, random sequences and stochastic processes, correlation functions and spectral densities, return period and extreme values, failure rates, performance monitoring and service life prediction.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4614

BMES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

BMES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 29844 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Building Construction (BC)

BC 1014 - Building A Strong Foundation for Success (2 credits)
Exploration of career options within the built environment and construction industry. Professional development, digital literacy, which will include creation of media and “personal brand” identity. Exploration of ideas from multiple viewpoints and perspectives. Oral, written, and visual presentation of ideas such as resume development. Introduction to ethical considerations. Reflection on “Self-as-Learner.” Critical-Thinking skills as they apply to construction projects. Development of group roles as they apply to construction projects. Identification of universities resources, policies, procedures, academic and social engagement opportunities.
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 1114 - Introduction to Building Construction (3 credits)
Introduction to construction with understanding of different market sectors, specializations, career path opportunities, industry stakeholders, and processes. Comprehension of quality assurance, control, project delivery systems, basic estimating, and scheduling. Application of communication skills to professional settings and use of basic calculations to solve construction math problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 1124 - Construction Documents and Safety (2 credits)
Role of construction drawings and specifications. Interpretation of construction documents and creation of basic project documentation. Health, safety, and environmental hazards encountered in the construction industry. Design Lab Studio (1H, 2L, 2C)
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

BC 1214 - Introduction to Building Construction I (3 credits)
Introduction to construction with an overview of construction drawings and specifications, construction terminology, building codes and building systems, cost estimating and bidding, construction management processes, construction documents, load paths and foundations, construction health and safety, and hands-on experiential learning through lab exercises. Strategic career success factors and introduction to ethical decisions in construction management.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 1224 - Introduction to Building Construction II (3 credits)
Overview of the important areas of contracting and the workings of the construction industry. Application of construction management theory, processes, and terminology including, definable building systems, building code interpretations, the reading and preparing of basic construction drawings and integrating construction details and project specifications to derive safe construction means and methods, equipment section, cost estimates and time schedules.
Prerequisite(s): BC 1214 or BC 1114
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2004 - Construction Surveying (1 credit)
Surveying in context of the construction process, basic surveying methods, equipment, emerging technologies, topographic surveying, and application to construction layout.
Prerequisite(s): BC 1124
Instructional Contact Hours: (1 Lec, 1 Crd)

BC 2014 - Construction Principles I (3 credits)
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2024 - Construction Principles II (3 credits)
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression.
Prerequisite(s): BC 2014
Corequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2044 - Construction Materials (3 credits)
Introduction to the life cycle, properties, behaviors, and sustainability impacts of common construction materials including wood, insulation, asphalt, ferrous and nonferrous metals, aggregate, concrete, masonry, glass, and plastics. Theory of materials including material properties; behavior under physical, thermal, and environmental loads; and interfaces between dissimilar materials. Methods and criteria for material comparison and selection for sustainable construction. Preparation of professional written reports as a team and individually; Project management for materials selection/application.
Corequisite(s): BC 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2064 - Integrated Construction I (3 credits)
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project.
Prerequisite(s): BC 2014 and BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2104 - Building Effective Construction Teams (3 credits)
Introduction to leadership behavior styles and their impact on construction management team performance, including analysis of how ethical behavior and individual strengths support positive relationship-building. Development of management strategies to maximize positive conflict outcomes through trust-building between construction project stakeholders. Identification of the role that implicit bias plays in decision-making within diverse project teams. Development of presentation skills for a construction audience.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2114 - Information Technology in Design and Construction (3 credits)
Building delivery and project management improvements through the use of information technology (IT) are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts that integrate design and construction. Use BIM/VDC tools for graphical presentations, databases, and spreadsheets.
Prerequisite(s): BC 1224 or CEM 2104 or BC 1124
Corequisite(s): BC 2014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2134 - Construction Data Analysis (2 credits)
Identification and use of various types and sources of construction market data and the tools for analyzing construction data to support managerial decision making. Different forms of applying mathematics to the construction market for better productivity and processes across the construction industry. Develop insights to inform management and investment decisions. Use of cost-benefit analysis as applied to construction management in determining feasibility of projects.
Prerequisite(s): MATH 1025 or MATH 1225
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 2214 - Why Buildings Stand Up (3 credits)
Overview of fundamental principles explaining why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Calculation of shear, bending moments, deflections in beams, and buckling. Discussion of ethical impacts on user safety and hazard avoidance, in project design and construction methods, materials, etc. Explores different types of soil composition and their strength properties.
Prerequisite(s): (BC 1224 or BC 1124) and (MATH 1025 or MATH 1225)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2354 - Residential Construction Technologies (3 credits)
Identify and evaluate conventional construction materials, methods, building systems, and products to less-familiar, innovative technological alternatives for a specific residential construction project. Compare innovative technological alternatives with material and cost estimates. Overview of conventional materials, equipment, designs, and processes in residential construction. Investigate recent literature on emerging technologies to determine best practices. Strengthen understanding of the primary building systems in residential construction applications.
Prerequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 3014 - Building Physics and Environmental Systems (3 credits)
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems.
Prerequisite(s): PHYS 2205 and PHYS 2215 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3064 - Integrated Construction II (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project.
Prerequisite(s): (BC 2064 or CEM 2104) and (PHYS 2205 and PHYS 2215 or PHYS 2305)
Corequisite(s): BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3114 - Building Systems Technology (3 credits)
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads.
Prerequisite(s): BC 2024 and (PHYS 2305 or PHYS 2205 and PHYS 2215) or (CEM 2104 and PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 3134

BC 3954 - Study Abroad (1-19 credits)
Study abroad in Spain.
Instructional Contact Hours: Variable credit course

BC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4024 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4014

BC 4064 - Integrated Construction III (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4114 - Building Information Modeling in Design and Construction (3 credits)
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming.
Prerequisite(s): BC 2114 or (ENGE 1215 and ENGE 1216)
Corequisite(s): CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4124 - Digital Construction & Manufacturing (3 credits)
Explore working principles, design projects, & experiment with construction digital information modeling, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Fundamentals of digital prototyping. Analysis of the industry tools such as 3D scanners, 3D printers, CNC manufacturing techniques, and others, used to provide familiarity with technologies & provide understanding of their benefits & limitations.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4164 - Production Planning and Process Design for Construction (3 credits)
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4264 - Fundamentals of Construction Management (6 credits)
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing.
Instructional Contact Hours: (6 Lec, 6 Crd)

BC 4314 - Building Performance and Energy Management (3 credits)
Fundamentals of building performance mandates for the built environment. Practical means and methods for evaluating building performance metrics within integrated design including acoustic performance, visual performance, and indoor air quality and management. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle.
Prerequisite(s): BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4324 - Innovation in Residential Construction (3 credits)
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4334 - Sustainable Building Performance Management (3 credits)
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning.
Prerequisite(s): BC 3064 and BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4364 - Lifecycle BIM for Facility Management (3 credits)
BIM (Building Information Modeling) concepts and tools that are critical for facility operation and maintenance. Identifying, capturing, analyzing, exporting and exchanging facility lifecycle data. Spreadsheet-based and BIM based facility management platforms. Case studies and real-life application for understanding mechanical, electrical, and plumbing systems from an owner or facility manager perspective. Workflow processes for data exchange.
Prerequisite(s): BC 2114 and BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4374 - Residential Housing and Land Development (3 credits)
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4434 - Construction Practice I (3 credits)
Explores advanced business and management practices and applications to vertical construction projects. Topics include scope, planning and scheduling, assemblies estimating, cash flow controls. Creation of work breakdown structure, application of concepts of assemblies estimating and general conditions to interpret insurance and contract requires along with digital construction practices.
Prerequisite(s): BC 3064 and BC 3114 and BC 3134
Corequisite(s): BC 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4444 - Construction Practice II (4 credits)
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals.
Prerequisite(s): BC 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BC 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

BC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Business (BUS)

BUS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BUS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BUS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BUS 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Business Information Tech (BIT)

BIT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 2104 - Careers in Business Information Technology (1 credit)
Career opportunities and job search strategies in the business information technology and operations fields with reference to the BIT courses that best help the student identify a career in his/her selected field. Includes career skills development and resume writing. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIT 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 2164, PSCI 2164

BIT 2405 - Introduction to Business Statistics, Analytics, and Modeling (3 credits)
Introduction to basic statistical (inference) tools, analytics techniques, and modeling necessary in managerial decision-making. The decision-making aspect of the course, while utilizing quantitative/computational thinking, will emphasize ethical reasoning. Topics include, but are not limited to, descriptive statistics, elementary probability theory, sampling and sampling distributions, portfolio management, hypothesis testing, regression analysis, analysis of variance, big data, and data analytics.
Prerequisite(s): MATH 1524 or (MATH 1225 and MATH 1226)
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2406 - Introduction to Business Statistics, Analytics, and Modeling (3 credits)
Overview of analytic models and solution techniques in decision science. Discussion of descriptive and predictive analytics goals and methods. In addition to overview of mathematical modeling and solution techniques, discussions will include considerations of adapting analytics methods to various global and ethical business applications. Students should develop skills and appreciation of the use of data and analytics for problem solving.
Prerequisite(s): BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2554 - Linux, Shell Scripting, and Securing the OS for Business (3 credits)
Build foundational knowledge of the Linux operating system and file system concepts necessary for cybersecurity business professionals. Discuss the purpose, use, architecture, and navigation of the Linux file system. Build skill using a command line operating system for system administration and security management tasks. Employ file and directory management, process management, text manipulation, and permissions in the Linux operating system. Create shell scripts for process automation, configuration and process management, and security applications. Hands-on experience securing and hardening the Linux operating system.
Prerequisite(s): BIT 2405
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop information technology or operations management related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

BIT 3414 - Operations and Supply Chain Management (3 credits)
Study of the process directly related to the creation and distribution of goods and services. Increasingly, these operations are taking place outside the boundaries of a traditional enterprise. This course teaches students how to analyze processes, ensure quality, create value, and manage the flow of information, products and services across a network of customers, enterprises and supply chain partners.
Prerequisite(s): BIT 2406 and ACIS 2116 and ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3424 - Introduction to Business Analytics Modeling (3 credits)
Introduction of modeling of problems encountered in business analytics. Statistical and optimization modeling, computer solution, and analysis of business problems. Uses spreadsheet and database software to facilitate the modeling and solution of these problems.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3434 - Advanced Modeling for Business Analytics (3 credits)
Study of selected, advanced topics in decision modeling and business analytics. Emphasis on model formulation, solution techniques, interpretation of results and comprehensive approaches to problem-solving. Integer, multi-criteria, and non-linear programming as well as network analysis and heuristics. Includes case studies and use of Excel as the primary analytical tool.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3444 - Advanced Business Computing and Applications (3 credits)
Study of selected advanced topics in business computing. Construction of business applications using an advanced application development environment such as Visual Studio.net. Coverage of computer terminology, HTML, and Internet applications. The course builds computer literacy and strong programming skills. Junior standing required.
Prerequisite(s): BIT 3424 and (CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3454 - Business Process Improvement (3 credits)
Examines the technical aspects of business process improvement focusing on improvement strategies, quality control, data analysis and mining, and maturity models. Emphasizes analytical techniques for business process design, control, and improvement.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3464 - Enterprise Planning and Control Systems (3 credits)
The study of the design, analysis and implementation of enterprise-wide resource planning and control systems. The course examines decision support models for production planning, master scheduling, inventory control, shop floor control and related topics in planning and control. The course emphasizes the application of information technologies such as ERP, MRPII, CIM to operations planning and control.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3474 - Data Management and Business Analytics in Python (3 credits)
Python for data wrangling and data analysis to support business decisions. Illustrate proficiency in Python, basic skills such as variables, functions, conditionals, loops, libraries, and data structures. Leverage Python skills to learn how to manage data. Learn how to clean, transform, and augment data, as well as how to use Python to obtain data, in particular to work with application programming interfaces (APIs) and do web scraping. Learn how to use Python to conduct data analysis and for plotting and visualization of data. Apply Python for time series data analysis and data modeling using libraries.
Prerequisite(s): CS 1064 and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3484 - Advanced Business Analytics in Python and R (3 credits)
Python and R for advanced data analysis, including predictive analytics and machine learning, to support business decisions. Use Python and R to conduct exploratory data analysis. Learn how to handle data, sampling distributions, statistical experiments, and significance testing in Python and R. Apply simple and multiple linear regression and related concepts such as confidence intervals, dummy variables, correlation, multicollinearity, confounding variables, interactions and main effects, and outliers. Learn how to apply classification, specifically NaÏve Bayes, discriminant analysis, and logistic regression. Learn how to apply model evaluation techniques such as ROC curves, AUC, and lift. Introduction to and application of machine learning, including k-nearest neighbors, tree models, principal component analysis, and hierarchical clustering.
Prerequisite(s): BIT 3474
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3514 - Systems Analysis (3 credits)
Study of the current technologies for designing and developing computer-based business systems. Topics will include process, structural, behavioral, and conceptual data modeling methodologies such as Uniform Modeling Language (UML) and important design-related issues such as data flows and system capabilities. Design issues will be explored through class projects. This course duplicates BIT 4524.
Prerequisite(s): CS 1054 or CS 1064 or CS 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3524 - Database Management and Design (3 credits)
Study of the design of databases and data structures for supporting business applications. Basic database structure and design, structured query language, database management systems, integration of backend database servers, data warehousing and mining, on-line analytical processing, and database application, security, and management. This course duplicates BIT 4514.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3554 - Networks, Telecommunications and Security (3 credits)
Provides an introduction to computer networks and data communications in business. Topics include mechanisms for reliable data transfer, network topologies and technologies, and a comprehensive treatment of inter-networking. Additional topics include packet switching, and cloud, edge, and advanced networking. Security issues related to using computer networks are discussed, along with network design issues, and methodologies for network applications. Duplicates BIT 4554.
Prerequisite(s): BIT 2405 or ACIS 3504 or BIT 2164 or CS 2164 or PSCI 2164
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ACIS 3554

BIT 3614 - Election Security (3 credits)
Election system and historical voting in the U.S., their inherent vulnerabilities, and how to locate and prepare against poor election security practices. Trust and cultural significance of voting in a democratic America. The election system security standards and regulations including the Virginia Department of Elections Voting Systems Security Policies, Standards, Guidelines, and Locality Election Security Standards (LESS). Threats, vulnerabilities, and attacks on election infrastructures and how they may be evaluated and mitigated. Security controls for voting systems, voter registration databases, and associated IT infrastructure and systems used to manage elections while exploring cybersecurity careers in the public sector. Prepares selected students for a summer internship supporting the Cyber Navigator Program with a specific Virginia Locality. Primarily designed for students majoring or minoring in cybersecurity, the course is open to all students of any major.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3664 - Cybersecurity Management I (3 credits)
Focuses on building general cybersecurity knowledge with an emphasis on cybersecurity management. This course will teach students about the categories of security controls. Students will be introduced to the necessity of cybersecurity through an introduction to cybersecurity concepts (e.g., threats, vulnerabilities, risk) and using basic tools to identify cybersecurity weaknesses (security assessments, passive and active reconnaissance, and vulnerability scanning). Students will learn about security policies and risk assessments and will perform a risk assessment. Students will be introduced to types of social engineering and malware tools and techniques. This class will introduce the legal and ethical aspects of security and privacy and the tools used to protect data privacy. Students will also learn to develop policies and procedures to manage hosts and explore how to harden one. This course will also introduce students to the management of internet of things (IOT) and cloud technologies, human resources security, incident response and forensics, physical and infrastructure security, and cybersecurity resilience.
Prerequisite(s): BIT 2554 and (BIT 3554 or ACIS 3554)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3674 - Cybersecurity Management II (3 credits)
Focuses on building general cybersecurity knowledge with an emphasis on the management and implementation of technical cybersecurity controls. This course will build knowledge of and teach students how to implement symmetric and asymmetric encryption. Students will learn about authentication and access controls and how to implement them, as well as understand and implement the network security protocols, standards, and applications that help support them. The course will also teach students how about database security practices and how to implement them, as well as build their understanding of firewalls, intrusion detection and prevention, buffer overflows, software security, wireless network security, and mobile security.
Prerequisite(s): BIT 3664
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4164, PSCI 4164

BIT 4424 - Business Information Visualization and Analytics (3 credits)
Basic perception and design principles and techniques for information visualization, with an emphasis on the application of visualization software for data exploration and the development of analytical skills for business. Includes hands-on exposure to information visualization and statistical software.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4434 - Computer Simulation in Business (3 credits)
In-depth study of the application of computer simulation techniques to business decision making and process improvement. The theory of computer simulation and statistical analysis of results are included. Attention is focused on using simulation software stressing application to specific problems.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4444 - Web-Based Decision Support Systems (3 credits)
Study of current technologies for designing and constructing interactive, Internet-based systems for supporting business decisions. Topics may include the operation of the Internet, server-side programming, client-side programming, server-side scripting, XML, XHTML, database integration, COM, CGI, and others. Design issues will be explored through a class project.
Prerequisite(s): BIT 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4454 - Business Analysis Seminar in IT (3 credits)
Comprehensive treatment of Decision Support Systems (DSS) as managerial tools, particularly in an e-commerce environment. Emphasis is at the builder and user level. A primary emphasis is on problem solving through the integration of various quantitative techniques as well as on IT concepts. The course includes a comprehensive project using state-of-the-art software.
Prerequisite(s): BIT 3434 and BIT 4444 and BIT 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4464 - Advanced Supply Chain Management (3 credits)
Advanced study of efficient methods for streamlining the production and delivery of products and services across functions, enterprises and global boundaries. Topics include the facilities, functions, technologies, and activities involved in creating and delivering products and services, especially in a digital marketplace. Designing and managing a network of suppliers across enterprises is discussed, along with the information systems, risk management and planning issues involved.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4474 - Global Operations and Information Technology (3 credits)
This course includes concepts and issues critical in the globalization of business operations and information technology. Topics covered include the organization of global operations, cultural and national comparisons, planning global operations, facilities location, product development, technology transfer, global communication links, transborder data flow, international information systems, and other emerging operations and information technology issues.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4484 - Project Management (3 credits)
Study of efficient methods for planning and controlling projects. Topics include project management and scheduling tools, project quality assurance, risk and cost control, resource constrained scheduling, definition and requirements analysis, task integration, and managing alliances. The application of information technology to project management and control is emphasized throughout the course.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4544 - Artificial Intelligence, Machine Learning, and Deep Learning in BIT (3 credits)
Learn concepts and techniques related to artificial intelligence (AI), machine learning (ML), and deep learning (DL). Learn the fundamentals of AI, ML, and DL algorithms and how to apply them to problems of interest to majors in the business information technology (BIT) department. Understand and apply supervised (classification, regression) and unsupervised (clustering) machine learning, and applications of these techniques in business. Apply deep learning, for example, recurrent neural networks (RNN), generative adversarial networks (GAN), and convolutional neural networks (CNN).
Prerequisite(s): BIT 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4604 - Data Governance, Privacy and Ethics (3 credits)
Examination of data analytics and automated decision making issues, across multiple technology contexts, through the lens of the humanities and ethics. Privacy, autonomy, data ownership, equality, and accountability. Decision making and exploration of questions of data ethics and data fairness throughout the data life cycle.
Prerequisite(s): BIT 2405 or CMDA 2014 or CS 1114 or CS 1054 or CS 1064
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4624 - Cybersecurity Analytics for Business (3 credits)
Application of advanced analytics to cybersecurity in a business setting. Categorization of cyber threats and solutions. Data mining, visualization and machine learning applied to large data sets for anomaly detection, threat prediction, and incident response analysis. Investigation of adversarial machine learning. Selection of appropriate analytics techniques and security platforms. Consideration of business and ethical issues.
Prerequisite(s): BIT 3674 or BIT 4614 or CS 4264
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4644 - Digital Forensics and Incident Response Management (3 credits)
Focuses on building knowledge about the field of digital forensics and incident response. Students will learn about cybercrime and the digital forensics process. The course will build knowledge of, and teach students how to implement, digital forensics techniques and tools. Students will learn about file systems, and how to work with Windows, Linux, and Macintosh file systems and forensic tools to acquire and analyze forensic evidence. Students will learn how to apply forensic tools and techniques to network, mobile, internet of things (IOT), cloud, email, social media, and dark web data and services. The course will also build knowledge about how to manage incident response capabilities such as computer security incident response teams (CSIRTs), incident response planning, guidance for processing crime and incident scenes, and how to compile forensic reports and integrate forensically obtained knowledge into future incident response planning.
Prerequisite(s): BIT 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4654 - Penetration Testing and Ethical Hacking for Business (3 credits)
Focuses on building competence in penetration testing for business. This course will teach principles of ethical hacking, such as system reconnaissance, enumeration, vulnerability scanning, and exploitation. Students will learn how to find and exploit vulnerabilities in web applications, operating systems, wireless networks, as well as perform social engineering and physical security assessments. Students will also perform penetration tests and learn to write reports for managerial audiences.
Prerequisite(s): BIT 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4854 - Analytics in Action (3 credits)
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations.
Corequisite(s): BDS 2005, CMDA 2014
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 4854

BIT 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Career and Technical Education (EDCT)

EDCT 1474 - Computer Information Systems (3 credits)
Fundamentals of Information Technology. Social and individual impact of technology. Software and hardware technologies. Networking, programming, and development.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 2604 - Introduction to Career and Technical Education (3 credits)
Philosophies, history, legislation, context, administration and delivery systems of the various licensure areas included in Career and Technical Education.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4004 - International Trends in Workforce Development (3 credits)
Trends in international workforce development including global talent supply and demand; portable skills and workforce readiness; social, economic and employment issues; worker values; impact of technology, and workplace communication skills for effective writing, speaking, reading, and listening.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4034 - Methods of Planning Educational Programs in Agriculture (3 credits)
Course examines the procedures involved in the development of courses, curriculum, and instructional materials for education programs in agriculture.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALCE 4034

EDCT 4624 - Managing a Career and Technical Education Program (3 credits)
Responsibilities of a Career and Technical Education teacher. Managing CTE program based on operational polices, promoting program to in-school and external stakeholders, implementing work-based learning, advising program student organizations, and creating a community-based program.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4634 - Student Assessment in Career and Technical Education (3 credits)
Assessment of standards-based outcomes of learning in workforce development and career and technical education programs. Focus on work-based learning, hands-on competencies, Cognitive Learning Targets, and performance assessment. Pre: Senior standing.
Prerequisite(s): EDCT 2604 and EDCT 2964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Pre: Recommendation of program area and successful completion of Professional Studies requirement.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)
Repeatability: up to 16 credit hours

EDCT 4884 - Youth Program Management (3 credits)
Organizational design of educational youth programs such as 4-H and FFA, including administrative planning, human resource development, recruitment, marketing, and budgeting.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALCE 4884

EDCT 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Chemical Engineering (CHE)

CHE 2004 - Chemical Engineering Sophomore Seminar (1 credit)
Career opportunities and current topics of interest in the Chemical Engineering profession.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHE 2114 - Mass and Energy Balances (3 credits)
Stoichiometric and composition relationships, behavior of gases, vapor pressures, solubility, mass balances, recycling operations, energy balances, first law of thermodynamics, thermophysics, thermochemistry, fuels and combustion, application to chemical operations.
Prerequisite(s): MATH 1226 and (CHEM 1036 or CHEM 1036H or CHEM 1056 or CHEM 1056H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 2164 - Chemical Engineering Thermodynamics (3 credits)
First and Second Laws, properties of fluids, properties of homogeneous mixtures; phase equilibria, chemical-reaction equilibria. Grade of C- or better required in prerequisite CHE 2114.
Prerequisite(s): CHE 2114 and MATH 2204 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 3015 - Process Measurement & Control (3 credits)
3015: Common process measurements; applications to theory and practice of automatic control of chemical processes; 3016: Design and laboratory practice underlying the automatic computer control of chemical processes.
Prerequisite(s): MATH 2214 and CHE 3114
Corequisite(s): 3124, (3184 or 3185), (3044 or 3154) for 3015
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3044 - Heat Transfer (2 credits)
One and two dimensional conduction, convection, and diffusion of thermal energy; heat transfer rates, steady state and unsteady state conduction, convection; design of heat exchangers; forced and free convection boiling and condensation.
Prerequisite(s): CHE 2164 and CHE 3114 and MATH 4564
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3114 - Fluid Transport (3 credits)
Fluid statics, surface tension, fluid dynamics, Newtons Law of viscosity, momentum transport, laminar and turbulent flow, velocity profiles, flow in pipes, flow around objects, non-Newtonian fluids, design of piping systems, pumps and mixing.
Prerequisite(s): CHE 2114 and PHYS 2305 and MATH 2204
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3124 - Chemical Engineering Simulations and Process Modeling (3 credits)
Development of strategies to pose and numerically solve sets of algebraic and differential equations that describe chemical engineering systems and processes. Iterative root finding and optimization approaches to solving non-linear equations, analyze data, and determine best-fit model parameters. Numerical strategies to integrate and differentiate models and data. Approaches to solve ordinary and partial differential equations that describe reaction kinetics, process control, and transport of momentum, heat and mass. Algorithm development, coding, and graphical representation of solutions. (3H,3C)
Prerequisite(s): CHE 2114 and MATH 2214
Corequisite(s): CHE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3134 - Separation Processes (3 credits)
Binary separations and multicomponent separations, distillation, batch distillation, extraction, absorption, McCabe-Thiele and Ponchon Savaret methods, short cut methods, design of plate columns, plate and column efficiencies.
Prerequisite(s): CHE 2114 and MATH 2204 and PHYS 2306
Corequisite(s): CHE 2164 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3144 - Mass Transfer (3 credits)
Multidimensional molecular diffusion and convection of single and multi-component systems; mass transfer rates; steady state, quasi-steady state and transient mass transfer; effect of reactions on mass transfer; convective mass transfer coefficients; design of stage and continuous gas/liquid contractors, membrane, liquid-liquid and liquid-solid separation processes, artificial kidney and drug delivery systems.
Prerequisite(s): CHE 3114 and CHE 2164 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3154 - Heat Transfer Analysis (3 credits)
Principles of conduction, convection, and radiation of thermal energy through one or more phases; analytical and numerical methods for modeling multi-dimensional and unsteady-state conduction; analysis of forced and free convection in conduits and around submerged bodies; design of heat exchangers; radiative heat transfer; boiling and condensation.
Prerequisite(s): CHE 2164 and CHE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3185 - Chemical Reactor Analysis and Design (2 credits)
Introduction to mathematical frameworks for analysis and modeling of chemical reactions within different reactor configurations. 3185: Reaction equilibria, power-law rate expressions, Arrhenius law, rate constants, analysis of kinetic data, design of single and multiple isothermal reactors. 3186: Reaction mechanisms, multiple reactions, selectivity, non-isothermal reactors, catalytic reactions and design of catalytic reactors.
Prerequisite(s): CHE 2114 and (MATH 2214 or MATH 2214H)
Corequisite(s): CHE 2164, CHE 3114
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3186 - Chemical Reactor Analysis and Design (2 credits)
Introduction to mathematical frameworks for analysis and modeling of chemical reactions within different reactor configurations. 3185: Reaction equilibria, power-law rate expressions, Arrhenius law, rate constants, analysis of kinetic data, design of single and multiple isothermal reactors. 3186: Reaction mechanisms, multiple reactions, selectivity, non-isothermal reactors, catalytic reactions and design of catalytic reactors.
Prerequisite(s): CHE 3185 and CHE 3114 and CHE 3144 and (CHE 3044 or CHE 3154)
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4014 - Chemical Engineering Laboratory (4 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. Applications include fluid flow, mixing, filtration, and distillation, process control, heat transfer, mass transfer, and chemical reaction kinetics. Consideration of ethical choices in engineering practice and societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 2164 and CHE 3015 and CHE 3114 and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3044 or CHE 3154) and CHE 3185 and ENGL 3764
Instructional Contact Hours: (12 Lab, 4 Crd)

CHE 4015 - Chemical Engineering Unit Operations Laboratory (2 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. 4015: Applications include fluid flow, mixing, filtration, distillation, and chemical reaction kinetics. Consideration of ethical choices in engineering practice. 4016: Applications in process control, heat transfer, mass transfer, and catalysis. Consideration of the societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 2164 and CHE 3114 and CHE 3124 and CHE 3134 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (6 Lab, 2 Crd)

CHE 4016 - Chemical Engineering Unit Operations Laboratory (2 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. 4015: Applications include fluid flow, mixing, filtration, distillation, and chemical reaction kinetics. Consideration of ethical choices in engineering practice. 4016: Applications in process control, heat transfer, mass transfer, and catalysis. Consideration of the societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 3015 and (CHE 3044 or CHE 3154) and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (6 Lab, 2 Crd)

CHE 4024 - Unit Operations and Scale-Up (1 credit)
Research of a chemical process unit, design of experiments, analysis and interpretation of experimental data, and scale-up of the unit to meet specific objectives. Teamwork, oral communication, and appropriate use of published information. Consideration of safety, and the societal and environmental impacts of an engineering design. Pre: In-major GPA of 2.0 or better is required.
Prerequisite(s): CHE 3015 and CHE 3044 and CHE 3124 and CHE 3134 and CHE 3144 and CHE 3184 and ENGL 3764
Instructional Contact Hours: (1 Lec, 1 Crd)

CHE 4104 - Process Materials (3 credits)
Basics of materials science as it relates to the interest of the chemical engineer. The course emphasizes the three fundamental areas of material science being polymer materials, metallics, and ceramic/inorganic glasses. The general molecular structure property - application behavior of each area will be presented but with a focus when possible on topics related to the field of chemical engineering.
Prerequisite(s): CHE 2164 and (CHEM 2535 or CHEM 2565)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4114 - Energy and Climate Change Solutions (3 credits)
Fundamentals of energy production technologies, alternative and renewable energy sources, electrochemical energy storage, direct carbon capture technologies, negative emissions technologies, and chemical process that use CO2 as a feedstock. Fundamentals of water purification technologies, the water cycle, and the impact of climate change on water resources and demands. Discussion of carbon and water economics, and how geographical, societal, and environmental factors affect energy and water management policies. Techno-economic analysis of solutions based on chemical technologies, and the communication of those solutions in the context of policy development.
Prerequisite(s): CHE 3144 and CHE 3185
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4144 - Business and Marketing Strategies for the Process Industries (3 credits)
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MKTG 4144

CHE 4185 - Process and Plant Design (4 credits)
Chemical process synthesis and plant design, economic analysis of alternative processes, process equipment design and specifications, computer-aided process design and simulation, design case studies, application of scientific and engineering knowledge to practical design problems. Grade of C- or better in all CHE prefix courses and in-major GPA of 2.0 or better is required.
Prerequisite(s): CHE 3015 and (CHE 3044 or CHE 3154) and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (4 Lec, 4 Crd)

CHE 4186 - Process and Plant Design (4 credits)
Chemical process synthesis and plant design, economic analysis of alternative processes, process equipment design and specifications, computer-aided process design and simulation, design case studies, application of scientific and engineering knowledge to practical design problems. Grade of C- or better in all CHE prefix courses and in major GPA of 2.0 or better is required.
Prerequisite(s): CHE 4185
Instructional Contact Hours: (4 Lec, 4 Crd)

CHE 4214 - Introduction to Polymer Materials (3 credits)
Basics of polymeric materials including description and categorization of macromolecules; characterization; mechanical properties; rubbery, glassy, crystalline, and viscous flow behavior.
Prerequisite(s): CHEM 2536 and CHE 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4224 - Introduction to Polymer Processing (3 credits)
Basic principles of momentum and heat transfer applied to the analysis of polymer processing operations. Introduction to polymer rheology.
Prerequisite(s): CHE 3144 and (CHE 3044 or CHE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4304 - Biological Transport Phenomena (3 credits)
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/ consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation.
Prerequisite(s): (CHE 3114 and CHE 3044 and CHE 3144) or (ME 3304 and ME 3404)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4344

CHE 4334 - Introduction to Colloidal and Interfacial Science (3 credits)
Properties and behavior of colloidal systems, primarily in liquid environments. Size characterization and description, Brownian motion, interparticle forces, dispersion stability, and experimental techniques for characterizing these systems.
Prerequisite(s): CHEM 3615 or CHE 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4404 - Machine Learning in Chemical Sciences and Engineering (3 credits)
Development and application of data-driven computational models. Focus on applications in chemical sciences and engineering (e.g., materials discovery, property prediction, anomaly detection, process optimization). Preprocessing, data management and visualization, clustering, classification, and regression algorithms, and common pitfalls and practices in training and evaluation of data-driven models. Pre: 3124
Prerequisite(s): CHE 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4544 - Protein Separation Engineering (3 credits)
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software.
Prerequisite(s): BSE 3504 or CHE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4544

CHE 4904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4994H - Undergraduate Research (1-19 credits)
Honors course
Instructional Contact Hours: Variable credit course

Chemistry (CHEM)

CHEM 1004 - First Year Experience in Chemistry (1 credit)
Orientation to the Chemistry Department and to the discipline of chemistry for chemistry majors and for individuals considering CHEM as a major, including transfer students. Resources for success, both generally as a college student and specifically as a chemistry major. Opportunities for mentoring, individual research and community involvement across the university and within the Chemistry Department. Exploration of career pathways for chemistry majors. Interconnections among professional practice, disciplinary progress, accepted standards for ethical use of information, principles of diversity and inclusion, and individual or personal value systems. Scientific communication, professional networking, and chemistry in the public eye.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 1014 - Calculations in Chemistry (3 credits)
Mathematical problem solving skills required for success in general chemistry. Manipulation of symbolic algebraic formulas. Dimensional analysis and narrative mathematical exercises. Application of problem solving techniques to chemical processes and reactions. Generation and interpretation of graphs using computer software. Elementary features of atoms, molecules, and the periodic table of the elements. Molar quantities, chemical nomenclature, reaction stoichiometry, and introductory solution chemistry.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1015 - Chemistry in Context (3 credits)
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1016 - Chemistry in Context (3 credits)
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1025 - Introduction to Chemistry Laboratory (1 credit)
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical consequences of decision- making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1026 - Introduction to Chemistry Laboratory (1 credit)
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical consequences of decision- making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1034 - General Chemistry Recitation (1 credit)
A companion course for students needing supplemental help with mathematical and problem-solving skills required for CHEM 1035 General Chemistry. Manipulation of algebraic formulas. Application of problem-solving techniques to chemical processes and reactions. Quantitative methods applied to unit conversions, reaction yields, energy of reactions, and gas properties. Examination of atomic structure, periodicity, and molecular bonding. May not count towards degree requirements; consult advisor. Pass/Fail only.
Corequisite(s): CHEM 1035
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 1035 - General Chemistry (3 credits)
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student's own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Properties of the three states of matter alone and in mixtures, kinetics, aqueous equilibrium, thermodynamics, electrochemistry. (Duplicates 1015-1016.) Students may bypass prerequisites for 1035 through testing alternatives listed in the Registrar's Timetable.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214 or MATH 1524
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1036 - General Chemistry (3 credits)
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student's own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Properties of the three states of matter alone and in mixtures, kinetics, aqueous equilibrium, thermodynamics, electrochemistry. (Duplicates 1015-1016.) Students may bypass prerequisites for 1035 through testing alternatives listed in the Registrar's Timetable.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1055H
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1045 - General Chemistry Laboratory (1 credit)
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214 or MATH 1524
Corequisite(s): CHEM 1035
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1046 - General Chemistry Laboratory (1 credit)
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing.
Prerequisite(s): CHEM 1045 or CHEM 1065
Corequisite(s): CHEM 1036
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1055 - General Chemistry for Chemistry Majors (4 credits)
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 1056 - General Chemistry for Chemistry Majors (4 credits)
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1055 or CHEM 1055H
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 1065 - General Chemistry for Chemistry Majors Lab (1 credit)
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214
Corequisite(s): 1055 or 1055H.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1066 - General Chemistry for Chemistry Majors Lab (1 credit)
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1065
Corequisite(s): 1056 or 1056H.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2114 - Analytical Chemistry (3 credits)
A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H
Corequisite(s): CHEM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2124 - Analytical Chemistry Laboratory Techniques and Practice (1 credit)
Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. Prior credit for OR concurrent registration of 2114 lecture is required for 2124 lab.
Prerequisite(s): CHEM 1046 or CHEM 1066
Corequisite(s): CHEM 2114
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2154 - Analytical Chemistry for Chemistry Majors (4 credits)
A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106
Corequisite(s): CHEM 2164
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 2164 - Analytical Chemistry for Chemistry Majors Lab (1 credit)
A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations.
Prerequisite(s): CHEM 1046 or CHEM 1066 or ISC 1116
Corequisite(s): CHEM 2154
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2424 - Descriptive Inorganic Chemistry (3 credits)
Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2514 - Survey of Organic Chemistry (3 credits)
Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required.
Prerequisite(s): (CHEM 1035 or CHEM 1055 or CHEM 1055H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2535 - Organic Chemistry (3 credits)
Structure, stereochemistry, reactions, and synthesis of organic compounds.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106 or ISC 1106H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2536 - Organic Chemistry (3 credits)
Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: One year of chemistry, including lab.
Prerequisite(s): CHEM 2535 or (CHEM 2565 or CHEM 2565H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2545 - Organic Chemistry Laboratory (1 credit)
The laboratory accompanies lectures in organic chemistry 2535 and 2536.
Prerequisite(s): CHEM 1046 or CHEM 1065 or ISC 1116
Corequisite(s): CHEM 2535, CHEM 2565
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2546 - Organic Chemistry Laboratory (1 credit)
The laboratory accompanies lectures in organic chemistry 2535 and 2536.
Prerequisite(s): CHEM 2545
Corequisite(s): CHEM 2536
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2555 - Organic Synthesis and Techniques Lab (2 credits)
Synthesis and characterization of organic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 1045 or CHEM 1065
Corequisite(s): CHEM 2565
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 2556 - Organic Synthesis and Techniques Lab (2 credits)
Synthesis and characterization of organic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 2555
Corequisite(s): CHEM 2566
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 2564 - Problem-Solving in Organic Chemistry (1 credit)
Writing organic reaction mechanisms; rationalizing and predicting organic reaction outcomes; selecting reagents for organic reactions; designing syntheses of several elementary steps; visualizing molecular stereochemistry.
Corequisite(s): CHEM 2565
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 2565 - Principles of Organic Chemistry (3 credits)
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1035H or CHEM 1055H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2566 - Principles of Organic Chemistry (3 credits)
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses.
Prerequisite(s): CHEM 2565
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

CHEM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 3004 - Bridge to the Future (1 credit)
Exploration and development of post-baccalaureate career options, including non-traditional options, for chemistry students. Opportunities in the government, private and academic sectors. Career planning. Managing application processes for graduate school, professional school, and employment. Development of materials (resumes, cover letters, portfolios, and personal statements) needed for applications. Fellowships and scholarships for graduate study. Opportunities for career-relevant experience before graduation. Integrity in career development. Open to majors in Chemistry, Medicinal Chemistry, and Polymer Chemistry.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 3054 - Postconsumer Materials (3 credits)
Chemistry and global impacts of postconsumer materials including trash, biodegradable, recyclable, and reusable materials. Waste management of metals, ceramics, and polymers in the context of their chemical properties. Reliability and accuracy of information sources on postconsumer materials. Complex contemporary issues involving disposal and repurposing of postconsumer materials including health impacts, energy, cost, water quality, return value, and environmental and cultural considerations.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3615 - Physical Chemistry (3 credits)
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4615, cannot receive credit for both 3615 and 4615.
Prerequisite(s): (CHEM 1035 or CHEM 1055 or CHEM 1055H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 2204 or MATH 2204H or MATH 2224)
Corequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3616 - Physical Chemistry (3 credits)
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4616, cannot receive credit for both 3616 and 4616.
Prerequisite(s): MATH 2214 and (CHEM 3615 or CHEM 3615H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3625 - Physical Chemistry Laboratory (1 credit)
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed.
Prerequisite(s): CHEM 3615 or CHEM 3615H or CHEM 4615 or CHE 2164
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 3626 - Physical Chemistry Laboratory (1 credit)
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. I
Prerequisite(s): (CHEM 3616 or CHEM 3616H or CHEM 4616) and CHEM 3625 and CHEM 4014
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 3684 - Quantum Software I (2 credits)
Organization of quantum information (assemblies of bits) for quantum-computing applications in chemistry, physics, biology, and computer science. Numerical methods for quantum software, emphasizing spin lattices and simulations such as quantum games. Best practices for programming, including techniques for quantum-coding (in Python or Julia), structuring a software product for quantum-computational science use, version control, and cloud-based documentation and code-sharing (via Github). Classical/quantum translation.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 3144
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: PHYS 3684

CHEM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CHEM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4014 - Survey of Chemical Literature (1 credit)
Use of the chemical literature as an aid to professional activities. Pre: Junior Major Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 4034 - Capstone Laboratory for BA Chemistry Majors (2 credits)
A senior-level laboratory course that integrates previous laboratory and lecture experiences to illustrate the interconnectedness of the curriculum leading to the BA in Chemistry. Modern experimental methods and instrumentation, including chromatographic separations, nuclear magnetic resonance, infrared spectrometry, and mass spectrometry. Independent experimental design and execution of an experimental synthetic reaction in chemistry, including scaling, selection of reagents and solvents, and development of a procedure for completing the reaction, isolating the product, and characterizing it for structure and bulk purity. Best practices in lab safety, chemical hygiene, note-keeping, and professional report-writing. Principles of green chemistry. Pre: Senior standing.
Prerequisite(s): CHEM 2164 and (CHEM 2546 or CHEM 2566)
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4074 - Laboratory in Polymer Science (2 credits)
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems.
Prerequisite(s): CHEM 4534 and CHEM 3625 and (CHEM 3615 or CHE 2164)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: MSE 4544

CHEM 4114 - Instrumental Analysis (3 credits)
Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124.
Prerequisite(s): CHEM 2154
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4124 - Instrumental Analysis Laboratory (1 credit)
Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations.
Prerequisite(s): CHEM 4114
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 4404 - Physical Inorganic Chemistry (3 credits)
A study of spectroscopic, bonding, and structural properties of inorganic compounds.
Prerequisite(s): (CHEM 3616 or CHEM 3616H) and CHEM 2424
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4414 - Inorganic Chemistry Lab (2 credits)
Synthesis and characterization of inorganic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 2424 and (CHEM 3616 or CHEM 3616H) and CHEM 4404
Corequisite(s): CHEM 3616, CHEM 4424
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4424 - Polysaccharide Chemistry (3 credits)
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 4424

CHEM 4434 - Organometallic Chemistry (3 credits)
Synthesis, structure, properties, and reactivity patterns of main-group and transitionmetal organometallic compounds. Applications of organometallic compounds in chemical synthesis and catalysis.
Prerequisite(s): CHEM 2424 and CHEM 2565 and CHEM 2566 and CHEM 4404
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4444 - Bioinorganic Chemistry (3 credits)
Principles underpinning the study of metal ions in biological systems. Review of basic coordination chemistry. Evolution of the distribution of metal ions in biology. Uptake of metal ions from the environment into living organisms. Regulation of metal ion concentrations in cells. Central functions of metal ions in biological systems including modulation of structure, electron transfer reactions, substrate binding and activation, and selective transfer of atoms and groups. Roles of biopolymers in the binding, regulation, and function of metal ions. Physical methods of analysis relevant to bioinorganic chemical research questions. Senior standing.
Prerequisite(s): (CHEM 2566 or BCHM 4115) and BIOL 1105 and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4514 - Green Chemistry (3 credits)
Sustainability, waste prevention, conservation of energy resources, avoidance of toxins, pollutants, and hazards in chemical processes and products. Life-cycle analysis applied to case studies involving process development and product stewardship. Applications in chemical industry, process and product design, and public policy.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4524 - Identification of Organic Compounds (3 credits)
Structure determination of organic compounds by spectroscopic methods. Interpretation of 1H and 13C nuclear magnetic resonance (NMR) spectra including two-dimensional (2D) spectra. Mass spectrometric (MS) techniques including tandem MS. Selection and application of minor organic-analytical techniques for structure elucidation. Formatting of spectroscopic data for publication. Course credit will not be awarded for both CHEM 4524 and CHEM 5524G.
Prerequisite(s): (CHEM 2536 or CHEM 2566) and (CHEM 3616 or CHEM 4616)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4534 - Organic Chemistry of Polymers (3 credits)
Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4544 - Medicinal Chemistry Capstone Laboratory (2 credits)
Laboratory experience tracing a standard pathway that potential drug targets follow in many medicinal chemistry laboratories. Synthesis of potential drug compounds and verification of their purity and structural identity primarily using mass spectrometry and nuclear magnetic resonance (NMR) spectroscopy. Optimization of conditions for a biochemical assay and verification of its reproducibility. Use of an optimized assay to measure the potency of potential drug compounds to achieve a desired biochemical effect. Application of structure-activity relationships to propose new chemical structures that might show further improvements in potency. Best practices in laboratory safety, chemical hygiene, note-keeping, and professional report-writing. Senior standing.
Prerequisite(s): CHEM 4584 and BIOL 1105 and BIOL 1106
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4554 - Drug Chemistry (3 credits)
Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4584 - Bioorganic Chemistry (3 credits)
The organic chemistry underlying the structure and properties of amino acids, peptides, and nucleic acids. Mechanisms of enzyme catalysis and coenzyme-mediated reactions. Mechanisms and thermodynamics of catabolism and anabolism of fats, carbohydrates, and proteins, and of other key biological reactions. Principles of solid-phase synthesis applied to peptides and nucleic acids. Biosynthesis of lipids, sugars, and terpenoids.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4615 - Physical Chemistry for the Life Sciences (3 credits)
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615.
Prerequisite(s): ISC 2106H or (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 1026 or MATH 1226)
Corequisite(s): PHYS 2206 or PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4616 - Physical Chemistry for the Life Sciences (3 credits)
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3616, cannot receive credit for both 3616 and 4616.
Prerequisite(s): ISC 2106H or (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 1026 or MATH 1226) and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4624 - Materials Chemistry in Energy Sciences (3 credits)
Fundamental principles of solid-state materials chemistry in energy sciences. Thermodynamics and kinetics of electron and ion transport in solid materials. Application of electrochemical and photochemical principles to batteries, fuel cells, solar cells, and other energy devices. Analytical tools and characterization methods for elucidating mechanisms within electrochemical and photoelectrochemical cells, with an emphasis on using electrochemical principles to evaluate battery chemistry. Solid-liquid interfacial mechanisms in energy devices. Critical analysis of relevant primary literature. Formulation of hypotheses and experimental design for improving device performance. Pre: Senior standing.
Prerequisite(s): CHEM 3615 or CHEM 4615
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4634 - Polymer and Surface Chemistry (3 credits)
Physical chemical fundamentals of polymers and surfaces including adhesives and sealants.
Prerequisite(s): CHEM 3615 or CHEM 4615
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4684 - Quantum Software II (1 credit)
Modern software collaboration techniques and tools including collaborative code repositories and cloud-based documentation. Application of structure and version control to software and documentation. Developing code with industry-standard quantum-software modules. Hands-on scientific coding for quantum problems. Project management skills including proposal development and technical presentation delivery.
Prerequisite(s): CHEM 3684 or PHYS 3684
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: PHYS 4684

CHEM 4734 - Environmental Soil Chemistry (3 credits)
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 and CSES 3124 or ENSC 3124 or GEOS 3624 and CHEM 2514 or CHEM 2535 and CHEM 2114 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENSC 4734

CHEM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

CHEM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Chinese (CHN)

CHN 1105 - Elementary Chinese (3 credits)
Fundamentals of the Chinese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Chinese.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 1106 - Elementary Chinese (3 credits)
Fundamentals of the Chinese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Chinese.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 1114 - Accelerated Elementary Chinese (6 credits)
Proficiency-oriented approach to Elementary Chinese, designed for learners who wish to progress rapidly through the beginning stages of language learning. Speaking, listening comprehension, reading comprehension, writing, and cultural competency at the novice-high level. Duplicates 1105 and 1106. For students with no prior knowledge of the language.
Instructional Contact Hours: (6 Lec, 6 Crd)

CHN 2105 - Intermediate Chinese (3 credits)
Emphasizes comprehension of written and spoken Mandarin Chinese, communication in Chinese; study of some literature and culture of the Chinese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): CHN 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2106 - Intermediate Chinese (3 credits)
Emphasizes comprehension of written and spoken Mandarin Chinese, communication in Chinese; study of some literature and culture of the Chinese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): CHN 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2734 - Chinese Culture and Civilization (3 credits)
Survey of Chinese culture and civilization through interactions between major political and historical events, social and artistic movements in China. Chinese literature, art, architecture, film, and theater in the context of Chinese cultural history. Aesthetic and rhetorical strategies. Interpretation of intercultural experiences from different vantage points. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 3105 - Advanced Chinese (3 credits)
3105: Practice in communication skills in Chinese both orally and in writing, including review of grammar, directed composition, and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3106 - Advanced Chinese (3 credits)
3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): CHN 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3124 - Chinese for Oral Proficiency (3 credits)
Formal conversation, business Chinese, and enhanced cultural competency. Discuss current topics and perform daily transactions. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3304 - Chinese Literature in Translation (3 credits)
Familiarization with the historical, intellectual, and cultural contexts of major Chinese literary genres. Identification of major cultural movements and concepts in Chinese literature and analysis of literary texts. Examination of aesthetic and rhetorical strategies employed in literary works. Intercultural experiences from different vantage points. The impact of globalization on Chinese literature. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3474 - Topics in Chinese Cinema (3 credits)
Critical issues in the history of modern and contemporary China through cinema. Interactions between major political and historical events and social and cultural movements in China. Chinese cinema in the broader contexts of Chinese cultural history and Chinese society. Interpretation of intercultural experiences from different vantage points. Variable topics such as national identity, social realities during the Republican era, the modernization of China, economic conditions and political responses, gender politics, the reform and opening-up of China, and the impact of globalization on Chinese cinema. Instruction in English. May be repeated once with different content for a maximum of 6 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CHN 3514 - Modern China through the Media (3 credits)
Acquisition of media Chinese through comprehending and analyzing various forms of mass media. Topics of community, national, or international interest. Language used in both formal and informal settings. Enhancement of societal and cultural knowledge through the mass media. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3524 - Introduction to Chinese Translation (3 credits)
Introduction to the translation of a variety of real-world materials from Chinese into English with the aid of online translation tools. Acquisition of relevant skills to analyze Chinese sentences into phrasal constituents, critique the quality of existing translated works, and create a portfolio of translation work.
Prerequisite(s): CHN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3534 - Business Chinese (3 credits)
Preparation for the business world in contemporary Modern Standard Chinese-speaking communities. Contextualized usage of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in spoken and written formats such as business correspondence, formal and informal reports, business documents, and business proposals. Taught in Chinese. Not recommended for native speakers.
Prerequisite(s): CHN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3544 - Introduction to Classical Chinese (3 credits)
Essentials of classical Chinese vocabulary and grammar. Simple texts in classical Chinese, translation of classical Chinese texts into idiomatic English, and recitations of selected short passages in the language. Not recommended for native speakers. Taught in Chinese.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3604 - Chinese Language and Society (3 credits)
Examination of the complex interaction between linguistic practices and social and cultural stratifications in Chinese speaking communities (e.g., Mandarin speakers). Identification of fundamental concepts in the field of sociolinguistics, explanation of the ways in which language expresses different social meanings, analysis of how identity is constructed through language and how belief systems about different identities influence human behavior and social relationships, identification of issues of diversity and inclusion, and interpretation of language behavior from different sociocultural contexts. Taught in English.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4614 - Teaching Chinese (3 credits)
Focus on practical activities of language learning, from a variety of learners' perspectives. Development of the ability to explain and apply activities for learning Chinese characters, sounds, vocabulary, and sentence patterns; ability to design conversation-based practice tasks.
Prerequisite(s): CHN 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Cinema (CINE)

CINE 2054 - Introduction to Cinema (3 credits)
Introduction to cinema as a medium for artistic communication. Interpretation and analysis of films to understand designs, ideas and values in artistic and cultural contexts. Basic elements of cinema structure and cinema terminology, phases of cinema production, cinema style of individual directors, creative work of cinematography, production design, and editing, ideological and social meaning in cinema, demographics of visual representation, cinemas economic marketplace. Ethical values and conflicts as found in given films, and ethical reasoning as part of the analysis of cinema.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CINE 2064 - Introduction to Cinema Production (3 credits)
Introductory filmmaking course. Thematic conception and story construction, writing, producing, directing, cinematography, sound recording, and editing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3184 - Cinema Production Topics (1-9 credits)
Rotating topics in cinema production. Designed for majors in the Department of Theatre and Cinema who have foundational training in areas of cinema production. May be repeated for credit with different course content up to a maximum of nine credit hours.
Prerequisite(s): CINE 3214 or CINE 3224
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

CINE 3214 - Fiction Cinema Production (3 credits)
Intermediate-level fiction film production course. Foundational cinema production skills, dramatic storytelling techniques, intermediate directing, team- based ownership and responsibility, and project management.
Prerequisite(s): CINE 2054 and CINE 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3224 - Documentary Cinema Production (3 credits)
Intermediate-level, non-fiction, film production course for students seeking non-fiction documentary film production skills and experience. Emphasizes the application and advancement of foundational skills, the ethics of documentary filmmaking, story development and project management.
Prerequisite(s): CINE 2054 and CINE 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3444 - African American Images in Film (3 credits)
Explores race and representations of African American images in film, from multiple disciplinary perspectives. Focuses on the social, political, economic, and historical milieu in which black film emerged and evolved. Examines gender issues in filmmaking. Reviews different genres, including race films, colorblind representations, and black exploitation films, and the appropriation of black representation and black images in film in the United States and elsewhere. Includes methods of film analysis, such as historical, master narrative structure, and archival research.
Prerequisite(s): AFST 1714
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 3444

CINE 3514 - American Cinema Genres (3 credits)
Close visual and cultural study of classic film genres with emphasis on cinematic styles and narrative conventions which unify the genre and which are found in representative films; exploration of genre films as symbols of American culture and society. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 3524 - The Cinema Director (3 credits)
Close thematic and visual analysis of the films of prominent cinema directors; emphasis on cinematic structure and development and evolution of their work. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits.
Prerequisite(s): TA 2054 or CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 3534 - Avant-Garde Cinema (3 credits)
Close visual and cultural study of the avant-garde and experimental tradition in the first half-century of American and European cinemas; emphasis on interrelations of cinema with avant-garde movements in other arts, including literature, music, dance, theatre, painting, and photography
Prerequisite(s): CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3544 - Literature and Cinema (3 credits)
Works of literature and the films into which they have been transformed; emphasis on differences between media.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3544

CINE 4084 - Cinema History (3 credits)
Aesthetic, economic, social and technological history of world cinema; film theory as it relates to the history of cinema. Junior standing required.
Prerequisite(s): CINE 2054
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CINE 4144 - Topics in Cinema Studies (3 credits)
Critical issues in cinema. Aesthetic, social, political, and economic contexts for films that embody or critique assumptions of historical periods. Analysis of ethnocentric and cultural biases in cinema. Identifying issues of identity and equity in films. Theories and ethics of representation. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): CINE 2054
Pathway Concept Area(s): 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 4534 - Underground Cinema and Culture (3 credits)
Close visual and cultural study of underground cinema and culture from the 1940s through the 1970s; emphasizes the interrelations of cinema with countercultural movements in other arts, including literature, music, dance, theatre, painting, and photography; focuses on the post-war avant-garde, the emergence of film societies, the neorealist and new wave cinemas, challenges to censorship laws, and the emergence of cult and midnight movies.
Prerequisite(s): CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)

Civil and Environmental Engineering (CEE)

CEE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2804 - Introduction to Civil and Environmental Engineering (3 credits)
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2814 - Geomatics (4 credits)
Introduction to data measurement issues in the civil and environmental engineering sub disciplines. Collection techniques, analysis, errors, statistical description and visualization. Spatial measurements such as leveling, distance and angles, mapping and topographic surveys, the Global Positioning System, LiDAR, terrain models, earthwork methods, construction surveying, coordinate systems, and Geographic Information Systems. Non-CEE students are exempt from the CEE 2834 corerequisite.
Prerequisite(s): ENGE 1216 or ENGE 1414
Corequisite(s): CEE 2834
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

CEE 2834 - Civil Engineering Drawings and Virtual Modeling (3 credits)
Introduction to the use of Computer-Aided Drafting, Building Information Modeling and Geographic Information Systems software. Interpretation of civil engineering drawings. Creation of civil engineering plans and two- and three- dimensional visualizations. Professional collaboration tools. Basemap creation. Basic analysis tools utilizing Geographic Information Systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3014 - Construction Management (3 credits)
Introduction to the fundamental elements involved in managing construction projects. Project lifecycle, delivery methods and contracts, equipment and labor productivity, scheduling, and cost estimating and control. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3104 - Introduction to Environmental Engineering (3 credits)
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations.
Prerequisite(s): CHEM 1035 and CHEM 1045 and (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024) and (PHYS 2305 or PHYS 2205)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3274 - Introduction to Land Development Design (3 credits)
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development.
Prerequisite(s): CEE 2814 and (CEE 2824 or CEE 2834)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3304 - Fluid Mechanics for Civil and Environmental Engineering (4 credits)
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. Design Lab/Studio. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): ESM 2104 and CEE 2804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3314 - Water Resources Engineering (4 credits)
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. Design Lab/Studio.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3404 - Introduction to Structural Engineering (3 credits)
Introduction to structural engineering as an art and science and its fundamental tenets; description of structural systems, structural loads, and load paths; structural models, case studies of successful and unsuccessful structural designs; calculations of forces and deformation for simple determinate structures (trusses, beams and simple frames) and indeterminate structures using virtual work, use of stiffness methods in computer programs.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3424 - Reinforced Concrete Structures I (3 credits)
Behavior and design of reinforced concrete members based on ultimate strength. Uncertainty, load and resistance factors. Load paths in framing systems. Beams, columns and slabs in flexure and shear. Deflections and crack control. Design of reinforced concrete members. Columns under axial forces, shear and flexure.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or BC 2044)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3434 - Design of Steel Structures I (4 credits)
Properties and behavior of structural steel. Design of steel members and connections using American Institute of Steel Construction specifications. Consideration of loads, structural safety, and serviceability. Design of members to resist tension, compression, and bending. Design of basic steel connections including tension connections, bearing plates, and base plates. Team-based design project to design a simple steel framed building. Design Lab/Studio.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or ESM 3054 or BC 2044)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3514 - Introduction to Geotechnical Engineering (4 credits)
Introduction to soil as an engineering material for construction and infrastructure support. Geological processes, soil classification, phase relations, geostatic and applied stresses, permeability, seepage effects, settlement, and strength. Laboratory testing, interpretation, and presentation of results. Application of geotechnical principles to civil and environmental engineering problems. Design Lab/Studio.
Prerequisite(s): ESM 2204 and GEOS 2104
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3604 - Introduction to Transportation Engineering (3 credits)
Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3684 - Civil Engineering Materials (4 credits)
Fundamental nature and performance of civil infrastructure materials, including metals, portland cement concrete, asphalt concrete, polymers, and wood. Material properties, microstructure, and mechanical behavior. Laboratory experimental procedures and standardized testing, property variability, durability, sustainability and resilience. Design of cementitious and asphalt mixtures, experimental design, non-destructive testing. Design lab/studio.
Prerequisite(s): CHEM 1045 and CHEM 1035 and ESM 2204 and GEOS 2104 and (CEE 2814 or CEM 2824)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3804 - Computer Applications for Civil and Environmental Engineers (3 credits)
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3814 - Analytical Tools in Civil and Environmental Engineering (3 credits)
Computer programming and data analysis for civil and environmental engineering projects. Acquiring, cleaning and pre-processing data sets. Probability distributions, hypothesis testing, and regression modeling. Time series and frequency analysis. Data visualization.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CEE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4014 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 4024

CEE 4024 - Construction Control Techniques (3 credits)
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4034 - Smart Sustainable Infrastructure (3 credits)
Challenges and barriers to sustainable infrastructure. Effects of a changing planet and society on current infrastructure systems. Technology and data use for engineering. Infrastructure data interpretation. Data-driven engineering solutions.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4074 - Construction Engineering: Means and Methods (3 credits)
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget.
Prerequisite(s): CEE 3014 or CEM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4104 - Water and Wastewater Treatment Design (3 credits)
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4114 - Fundamentals of Public Health Engineering (3 credits)
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4134 - Environmental Sustainability - A Systems Approach (3 credits)
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4144 - Air Resources Engineering (3 credits)
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4174 - Solid and Hazardous Waste Management (3 credits)
Introduction to the problems, regulations and techniques associated with the management of solid and hazardous waste. Composition, volume and characterization of the wastes. Design of collection and disposal systems, including landfills, solidification/stabilization and incineration. A grade of C- or better required in pre-requisite 3104.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4254 - Municipal Engineering (3 credits)
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4264 - Sustainable Land Development (3 credits)
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4274 - Land Development Design (3 credits)
Overview of land development projects including construction practices, legal issues, and government policies. Feasibility study, engineering evaluation. Grading and roadway design, layout design of lots, buildings, streets, sewers, and stormwater control. Interactive graphics and automated drafting.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4284 - Advanced Land Development Design (3 credits)
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required.
Prerequisite(s): CEE 3274
Corequisite(s): CEE 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4304 - Hydrology (3 credits)
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4314 - Groundwater Resources (3 credits)
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4324 - Open Channel Flow (3 credits)
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4334 - Hydraulic Structures (3 credits)
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4344 - Water Resources Planning (3 credits)
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4384 - Coastal Engineering (3 credits)
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4394 - Urban Water Sustainability (3 credits)
Coupled socio-hydrologic feedback loops and implications for water systems resilience. Urban water transitions theory and the evolution of water systems through time. Water productivity and the soft path for water. Ecosystem services. Urban water system challenges, including climate change, urbanization, equity and environmental justice, and water security. Centralized and distributed drinking water, stormwater, and wastewater treatment systems. Statistical analysis of urban water systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4404 - Intermediate Structural Analysis (3 credits)
Analysis of statically indeterminate 2D and 3D beam, truss and frame structures by the force and displacement methods. Computer implementation of force method. Influence lines and approximate methods of analysis.
Prerequisite(s): CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4454 - Masonry Structural Design (3 credits)
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures.
Prerequisite(s): CEE 3684 and CEE 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4514 - Methods in Geotechnical Engineering (3 credits)
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4534 - Earth Pressures and Foundation Structures (3 credits)
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4544 - Design of Earth Structures (3 credits)
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4554 - Natural Disaster Mitigation and Recovery (3 credits)
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4564 - Introduction to Coastal and Marine Geotechnics (3 credits)
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is required in prerequisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4604 - Traffic Engineering (3 credits)
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4610 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4044

CEE 4614 - Concrete Materials (3 credits)
Fundamental properties of portland cement concretes. Concrete mixture design procedures. Testing of fresh and hardened properties of concrete. Durability and degradation mechanisms. Condition assessments, forensic materials engineering, and repair strategies.
Prerequisite(s): CEE 3684 or BC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4624 - Planning Transportation Facilities (3 credits)
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4634 - Infrastructure Condition Assessment (3 credits)
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4654 - Geometric Design of Highways (3 credits)
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4664 - Pavement Design (3 credits)
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4674 - Airport Planning and Design (3 credits)
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4684 - Transportation Safety (3 credits)
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4694 - Freight Operations (3 credits)
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4804 - Professional and Legal Issues in Civil Engineering (3 credits)
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): CEE 2804
Corequisite(s): CEE 3304
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4814 - Risk and Reliability Analysis in Civil and Environmental Engineering (3 credits)
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4824 - Introduction to Forensic Engineering (3 credits)
Basic processes in engineering failure investigations: response, data gathering, testing, modeling, and reporting. Origins of natural and man-made disasters, role of building codes and material specifications, standard of care, ethical standards and legal issues as related to forensic engineering.
Prerequisite(s): CEE 3684 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4834 - Cyber-Physical and Remote Sensing Methods in Civil Engineering (3 credits)
Cyber-physical systems and remote sensing methods in civil engineering. Electrodynamics and fundamental physical operating principles. Sensing and sensor deployment strategies. Data acquisition and reduction. Signal and image processing techniques. Data interpretation, management, and curation.
Prerequisite(s): CEE 3814 or BSE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4844 - Building Information Modeling and Integrated Practices (3 credits)
Introduction to Building Information Modeling (BIM). Architectural modeling, custom parametric object creation, virtual structural modeling. Constructability and construction management analysis. Reality capturing technologies. Virtual reality and immersive virtual environments. Contemporary topics and new directions for BIM technologies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Classics (CLA)

CLA 1134 - The Ancient Mediterranean World (3 credits)
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as their influence on later and modern cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 1134

CLA 2224 - Ancient Greek and Roman Women (3 credits)
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2224

CLA 2234 - Classics in the Modern World (3 credits)
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2234

CLA 2244 - Cities of Rome (3 credits)
Examines the building development of the ancient city of Rome and selected Roman cities; investigates how social, political, and cultural aspects of private and public architecture in these physical cities both create meaning and preserve memory. Explores the ways in which later cultures, especially through literature, have engaged with the pervasive and persistent influence of ancient Rome, not just as a physical place, but also as a cultural construct.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2244

CLA 2434 - Fairytale, Folklore, and Magic: Popular Literature in Ancient Greece and Rome (3 credits)
Survey of ancient Greek and Roman popular literature. Introduces students to a wide array of texts, ranging from the ancient novel, popular compilations (e.g. books of marvels, fables, and jokes), ritual texts, funerary inscriptions, and folklore/fairytales. Examination of how scholars define popular literature as a category and introduction of contemporary approaches to it. Exploration of the connection of ancient Greek and Roman tales to international ones from different cultures and perspectives. Special attention to the depiction of private rituals in Greek and Latin literature. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CLA 2444 - Ancient Greek and Roman Mythology (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2444, RLCL 2444

CLA 2454 - Topics in Ancient Greek and Latin Literature (3 credits)
Examines canonical and non-canonical ancient Greek and Latin literary texts in translation and subsequent uses, adaptations and interpretations of these texts in various cultures. Examines concepts common to the humanities. Investigates the interaction and interdependence of literary texts with philosophy, art, music, history, and society. Identifies the uses, influences, and interpretation of these literatures. Examines significance of ancient Greek and Latin literature even though distant from our own space, time and experience. Identifies instances of cultural diversity and inclusion in these works. Taught in English. May be repeated 2 times with different content for a maximum of 9 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CLA 2464 - Mythology, Philosophy and Video Games (3 credits)
Examines how both ancient texts and modern games convey fundamental concepts of the humanities such as community, communication, agency, archetypes, the monomyth, morality, ethics, gender issues, environmental issues, aesthetic experience, xenophobia, and xenophilia. Evaluates the interaction of philosophy, art, technology, mythology, society and entertainment, and combines uses of modern technology and functions of ancient mythology across cultures and communities. Demonstrates the integration of concepts of the humanities as presented in video games.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CLA 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

College of Science (COS)

COS 1004 - Explore Science Seminar (2 credits)
Overview of the college and its degrees as well as the various career opportunities available to College of Science graduates. Introduction to University resources that aid in strategic academic and career planning. Intended for first-year Explore Science majors in the College of Science.
Instructional Contact Hours: (2 Lec, 2 Crd)

COS 1015 - Successful Starts in Science: Curie and Da Vinci Living Learning Communities (1 credit)
First year experience course for students living in the Curie or Da Vinci Living Learning Communities at Virginia Tech. Provides resources and fundamental skills to enhance learning experiences and support academic success in the sciences. Engages students with professional and academic development activities both in the classroom and within a science-themed residence hall. Uses a learn by doing approach to blending technical know-how with leadership, ethical, interpersonal and professional skills fundamental to the practice of science. Requires teamwork to envision, design, and implement research projects while using innovative discipline-specific technology. Provides first-year students with support through a weekly peer mentoring program. 1015: Emphasis on scientific inquiry, curriculum planning, career planning in the sciences, skills to promote academic success, awareness of academic and career resources and opportunities. 1016: Emphasis on collaborative problem-solving skills using innovative discipline-specific technology, critical thinking; Integration of ideas and experiences to encourage life-long learning through service work related to their academic/ career interests.
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 1016 - Successful Starts in Science: Curie and Da Vinci Living Learning Communities (1 credit)
First year experience course for students living in the Curie or Da Vinci Living Learning Communities at Virginia Tech. Provides resources and fundamental skills to enhance learning experiences adn support academic success in the sciences. Engages students with professional and academic development activities both in the classroom and within a science-themed residence hall. Uses a learn by doing approach to blending technical know-how with leadership, ethical, interpersonal and professional skills fundamental to the practice of science. Requires teamwork to envision, design, and implement research projects while using innovative discipline-specific technology. Provides first-year students with support through a weekly peer mentoring program. 1015: Emphasis on scientific inquiry, curriculum planning, career planning in the sciences, skills to promote academic success, awarenenss of academic and career resources and opportunities. 1016: Emphasis on collaborative problem- solving skills using innovative discipline-specific technology, critical thinking; Integration of ideas and experiences to encourage life-long learning through service work related to their academic/career interests.
Prerequisite(s): COS 1015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2015 - Professional Leadership in Science: Curie and Da Vinci LLC Leadership Course (1 credit)
Leadership and professional development course for sophomore science majors in the Curie and Da Vinci Living Learning Communities (LLCs). Applied experience in fundamental leadership and project management skills associated with practice of science, gained through service learning within the LLC. 2015: Academic peer mentoring, application and development of leadership and communication skills; application and development of project planning, organizational and collaboration skills; emphasis on written communication skills. 2016: Application of team mentoring and project management skills, including project planning and coordination, leadership strategies, collaboration, communication, conflict resolution, understanding group dynamics and the importance of diversity, and facilitating group discussion on scientific problem solving; emphasis on verbal communication skills.
Prerequisite(s): COS 1016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 2016 - Professional Leadership in Science: Curie and Da Vinci LLC Leadership Course (1 credit)
Prerequisite(s): COS 2015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 2164 - Introduction to Scieneering (1 credit)
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction to interdisciplinary thinking and communication; issues related to interdisciplinary research teams.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: ENGR 2164

COS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 3015 - Applications of Leadership in the Orion Science Living Learning Community (1 credit)
Applications of science leadership for sophomore through senior students in the Orion Science Living Learning Community (LLC). Students learn leadership skills while mentoring and designing activities to help younger students develop skills needed to succeed in college and future science careers. 3015: Recognize the needs of first- and second-year college students: help students find their own solutions; cooperatively plan and run activities that help first- and second-year college students develop professional skills and meet learning objectives; practice communication and motivation skills; model professional and ethical conduct; assess self as a learner and a leader. 3016: Coach teams and manage projects: help first- and second-year college students to apply their existing knowledge to a new project; identify problem-solving strategies and propose solutions; facilitate teamwork; communicate scientific information to the public in writing and orally; articulate the relationship between service to others and effective leadership.
Prerequisite(s): COS 1016 or COS 2016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 3016 - Applications of Leadership in the Orion Science Living Learning Community (1 credit)
Applications of science leadership for sophomore through senior students in the Orion Science Living Learning Community (LLC). Students learn leadership skills while mentoring and designing activities to help younger students develop skills needed to succeed in college and future science careers. 3015: Recognize the needs of first- and second-year college students: help students find their own solutions; cooperatively plan and run activities that help first- and second-year college students develop professional skills and meet learning objectives; practice communication and motivation skills; model professional and ethical conduct; assess self as a learner and a leader. 3016: Coach teams and manage projects: help first- and second-year college students to apply their existing knowledge to a new project; identify problem-solving strategies and propose solutions; facilitate teamwork; communicate scientific information to the public in writing and orally; articulate the relationship between service to others and effective leadership.
Prerequisite(s): COS 3015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4015 - Supervision in Science: Orion Living Learning Community (1 credit)
Supervision in Science is a course for junior through senior students in the Orion Living Learning Community (LLC). Students learn more advanced management and supervisory skills while working closely with Orion LLC faculty and staff to build on previously learned mentorship, leadership, and lesson/event planning skills to help younger students develop skills needed for success in college and future science careers. 4015: Recognize the needs and manage activities of first, second, and third year college students: assess self as a peer supervisor; develop an individual development plan (IDP) for peer supervisors with Orion LLC Directors; model professional and ethical conduct; effectively and positively motivate teams of first, second, and third year students to meet learning objectives and develop professional skills; help first, second, and third year college students effectively and professionally communicate needs. 4016: Apply supervisory skills to managing and coaching student teams toward completion of program activities and projects: reassess and revise individual development plan (IDP) for peer supervisory role with Orion LLC Directors; help second and third year college students effectively motivate and guide first year students toward the completion of a group research project; help younger students communicate scientific information to the public orally and in writing; facilitate conflict resolution; promote professional and timely communication for second and third year college students; articulate the role of supervision as an aspiring science professional.
Prerequisite(s): COS 3016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4016 - Supervision in Science: Orion Living Learning Community (1 credit)
Supervision in Science is a course for junior through senior students in the Orion Living Learning Community (LLC). Students learn more advanced management and supervisory skills while working closely with Orion LLC faculty and staff to build on previously learned mentorship, leadership, and lesson/event planning skills to help younger students develop skills needed for success in college and future science careers. 4015: Recognize the needs and manage activities of first, second, and third year college students: assess self as a peer supervisor; develop an individual development plan (IDP) for peer supervisors with Orion LLC Directors; model professional and ethical conduct; effectively and positively motivate teams of first, second, and third year students to meet learning objectives and develop professional skills; help first, second, and third year college students effectively and professionally communicate needs. 4016: Apply supervisory skills to managing and coaching student teams toward completion of program activities and projects: reassess and revise individual development plan (IDP) for peer supervisory role with Orion LLC Directors; help second and third year college students effectively motivate and guide first year students toward the completion of a group research project; help younger students communicate scientific information to the public orally and in writing; facilitate conflict resolution; promote professional and timely communication for second and third year college students; articulate the role of supervision as an aspiring science professional.
Prerequisite(s): COS 4015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4064 - Scieneering Capstone (3 credits)
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor.
Prerequisite(s): ENGR 2464 or BIOL 2124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGR 4064

COS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Communication (COMM)

COMM 1004 - First-Semester Experience in Communication (1 credit)
Introduction to areas of research, ethical behaviors, and career paths in the discipline. Consideration of strategies for learning, accessing advising, and locating resources.
Instructional Contact Hours: (1 Lec, 1 Crd)

COMM 1014 - Introduction to Communication (3 credits)
Survey of the communication discipline across areas of specialization from interpersonal to mediated and mass communication, including history and fundamental concepts, theories, contexts. Emphasis on ethical human behavior and message analysis.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 1015 - Communication Skills (3 credits)
Introduction to oral and written communication. 1015: Focus on oral and written communication in interpersonal, small group, and public contexts. Special emphasis on the writing process, listening, interviewing, conflict resolution, critical analysis, and communication in digital and visual media. 1016: Continued Study in oral and written communication skills for small group and public contexts. Focus on practical applications in ethical research and information gathering, audience analysis and adaptation, message development, and oral, written, and visual presentations by individuals and groups.
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 1016 - Communication Skills (3 credits)
Introduction to oral and written communication. 1015: Focus on oral and written communication in interpersonal, small group, and public contexts. Special emphasis on the writing process, listening, interviewing, conflict resolution, critical analysis, and communication in digital and visual media. 1016: Continued Study in oral and written communication skills for small group and public contexts. Focus on practical applications in ethical research and information gathering, audience analysis and adaptation, message development, and oral, written, and visual presentations by individuals and groups.
Prerequisite(s): COMM 1015
Pathway Concept Area(s): 1F Discourse Foundational, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2004 - Public Speaking (3 credits)
Strategies and practice for speaking to specific audiences. Ethical considerations for message preparation, development, presentation, and evaluation. Pre: Sophomore standing.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2014 - Communication Principles of Teamwork (3 credits)
Behavior of people working in groups. Theories and models of communication, types of groups, principles of effective teamwork. Intrapersonal and interpersonal communication and values related to group behavior, relationships, and problem solving. Ethical issues associated with group work. Pre: Sophomore standing required.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2024 - Media Writing (3 credits)
Writing and information gathering skills including news, features, press releases, and advertising copy for broadcast, print and public relations media. Sophomore Standing Required.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2084 - Media and Society (3 credits)
An examination of media influence on society. Emphasis on impact of media (such as newspapers, film, social networks, and video games) on diverse audiences and cultures. Considerations of the evolution of media; social institutions and trends related to the media; domestic, global, ethical, and legal questions posed by the media; intercultural communication; and new technologys influence on society.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2094 - Communication and Issues of Diversity (3 credits)
Study of communication theory and practice related to diversity and the media. Analysis of ethical implications of media influences on workplace communication across disciplines. Development of a personal understanding of diversity and identity by examining media producers, audiences, workforces, outlets, and content.
Prerequisite(s): COMM 1016 or ENGL 1106
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2124 - Introduction to Communication Research (3 credits)
Study of approaches to research in the discipline, including identification and analysis of existing research; procedures for conducting and reporting basic research in communication. Sophomore Standing required.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2754H - Topics in Single Medium Communication About Technology Innovation (1 credit)
Study of discovery, analysis, creation, and evaluation of single medium - written or spoken or visual - presentations of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape written, oral, or visual expression in the United States and vice versa. Special attention to single medium communications with stakeholders in business, government agencies, nonprofit organizations, and universities. Ethical dimensions of written, spoken, or visual communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): COMM 1016 or ENGL 1105
Pathway Concept Area(s): 1F Discourse Foundational, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

COMM 2764H - Topics in Multimedia Communication About Technology Innovation (1 credit)
Study of the discovery, analysis, creation, and evaluation of multimedia presentation of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape multimedia expression and vice versa. Special attention to communicating across disciplinary, organizational, and cultural differences in the workplace. Ethical dimensions of multimedia communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): COMM 2754H
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

COMM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

COMM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4024 - Communication Law (3 credits)
Study freedom of speech and the press and how these freedoms apply to the press, public relations, advertising and personal speech. Consideration of First Amendment theories and jurisprudence; related ethical issues. Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 4204 - Communication Internship (1-6 credits)
Placement in a communication industry for practical internship under supervision by a departmental advisor and a professional in the field. May be repeated for credit up to a maximum of 6 hours credit. Pre: Junior standing and consent required.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

COMM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Communication Studies (CMST)

CMST 2034 - Visual Media (3 credits)
Planning and production of visual messages for delivery through print, photography, videography, websites, social media, and mobile applications. Theories and principles of visual communication important to individuals working in communication jobs. COURSE FEE $59. Pre: Sophomore standing
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 2064 - The Tradition of Rhetoric and Societal Change (3 credits)
Key theories and figures in rhetoric over the past 2,500 years. Evolution of rhetorical and critical perspectives in communication. Dynamic, critical nature of persuasive communication. Methodological approaches to rhetorical criticism, ethics of message creation, communication contexts, emerging perspectives, and impact of changing culture/society on rhetorical theory.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3024 - Digital Publishing (3 credits)
Study and contemporary practices in digital publishing aimed at multichannel distribution for diverse audiences. Principles, standards, workflows, technologies, and strategies for ethical and accessible design and automation of content for Web, mobile, print, multimedia, and voice environments.
Prerequisite(s): COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3044 - Oral Communication Center Practicum (1 credit)
Focus on peer pedagogy in a communication center to support development of oral communication competence among students across disciplines. Emphasis on oral communication theory applied to one-on-one support for students oral presentations. May repeat 1 time.
Prerequisite(s): COMM 1016 or COMM 2004
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

CMST 3064 - Persuasion (3 credits)
Theoretical foundations of persuasion; techniques of persuasion; contemporary persuasive practice and campaigns; persuasive media strategies. Junior standing required.
Prerequisite(s): COMM 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3074 - Persuasive Public Speaking (3 credits)
Advanced critical analysis, preparation and presentation of persuasive speeches. Study of advanced rhetorical principles with emphasis on policy speeches and the use of proofs to convince, strengthen beliefs, and motivate listeners to overt action. Advanced focus on approaches to research, audience analysis, effective organization and extemporaneous delivery.
Prerequisite(s): COMM 1016 or COMM 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3124 - Interpersonal Communication (3 credits)
Basic theories and processes of person-to-person communication; interpersonal perception; verbal and nonverbal communication; establishment of relationships in the family and work situation. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3134 - Public Advocacy (3 credits)
Practical reasoning and argumentation about questions of community significance, emphasizing critical thought, rhetorical strategies, and advocacy. Junior standing required.
Prerequisite(s): COMM 2004 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3164 - Group Processes and Presentations (1 credit)
Study of group theory and its application to a group project, including team dynamics and leadership, conflict resolution, project management, and team presentation strategies.
Instructional Contact Hours: (1 Lec, 1 Crd)

CMST 3214 - Professional Communication (3 credits)
Theory and contemporary practice of professional oral communication, including interpersonal interaction, small group problem-solving, and public presentations. Emphasis on ethical exchanges in traditional or virtual workshops settings.
Prerequisite(s): COMM 1016 or COMM 2004
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3264 - Communication and Gender (3 credits)
Examines how verbal, nonverbal, and visual communication create, sustain, and challenge the meaning of gender and cultural structures and practices. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3274 - Social Dimensions of Games, Simulations, and Virtual Environments (3 credits)
Social impacts, key issues, and research findings related to video games, simulations, and virtual environments. Ethical, policy, and social dimensions in society; industry data and research. Prerequisite: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4174 - Digital Advocacy Campaigns (3 credits)
Study of advocacy campaigns with digital components. Rhetorical considerations in message construction, analysis of persuasive techniques, ethical standards, and strategies for campaign development. Senior standing required.
Prerequisite(s): (COMM 1016 or COMM 2004) and COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4214 - Web Content Management Strategies (3 credits)
Methodologies, tools, and strategies for managing workflow of communication projects for Web distribution. Software tools for Web-based communication. Quantitative and qualitative methods for usability and readability of Web content. Web analytics and content metrics to support decision making.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4224 - Topics in Media Criticism (3 credits)
Selected topics in media criticism. Offered on demand. Senior standing and consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4244 - Topics in Communication (3 credits)
Selected topics in communication. Application of theory and research in selected context. Ethical and social dimensions of communication issues, policies, and effects. May be repeated with different content for a maximum of 6 credit hours. Pre: Junior standing.
Prerequisite(s): COMM 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CMST 4284 - Communication for Training and Development (3 credits)
Communication principles and practices for training and development. Communication roles, strategies, and products for learning in workplace environments.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4714 - Senior Seminar in Communication (3 credits)
In-depth study of an issue or theme in communication. Communication theories, issues, policies, effects, and contexts. Research and presentation of research. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

Comp Modeling & Data Analytics (CMDA)

CMDA 1634 - Discovering Computational Modeling and Data Analytics (3 credits)
An introduction to the practice and profession of Computational Modeling and Data Analytics. Acquaints students with foundational computational tools, solving problems with modeling and data, visualization, ethical considerations in data science, professional opportunities in the field, and advising resources at Virginia Tech.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2005 - Integrated Quantitative Sciences (6 credits)
2005: Integrated topics from quantitative sciences that prepare students for advanced computational modeling and data analytics courses. Topics include: probability and statistics, infinite series, multivariate calculus, linear algebra. 2006: Intermediate linear algebra, regression, differential equations, and model validation.
Prerequisite(s): MATH 1226
Corequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (6 Lec, 6 Crd)

CMDA 2006 - Integrated Quantitative Sciences (6 credits)
2005: Integrated topics from quantitative sciences that prepare students for advanced computational modeling and data analytics courses. Topics include: probability and statistics, infinite series, multivariate calculus, linear algebra. 2006: Intermediate linear algebra, regression, differential equations, and model validation.
Prerequisite(s): CMDA 2005 and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (6 Lec, 6 Crd)

CMDA 2014 - Data Matter (3 credits)
This course develops fundamental analytical and programming skills to complete the "analytic pipeline", including specifying research questions, selecting/collecting data ethically and responsibly, processing and summarizing datasets, and stating findings, while considering all assumptions made. Students will identify vulnerabilities in analyses, including sources of bias and ethical implications. Some programming skills recommended, but not required. Some prior use of data recommended, but not required.
Prerequisite(s): MATH 1014
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2984E - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

CMDA 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 3274 - Introduction Sports Analytics (3 credits)
Introduction to sports analytics, sources of sports analytics data and data collection methods, visualization techniques, game performance statistics, inferential statistics and predictive modeling techniques for sports data. Role and applications of data analytics in the sports industry.
Prerequisite(s): CMDA 2006 or STAT 3006
Corequisite(s): CMDA 3654 or CS 3654 or STAT 3654.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 3274

CMDA 3605 - Mathematical Modeling: Methods and Tools (3 credits)
3605: Mathematical modeling with ordinary differential equations and difference equations. Numerical solution and analysis of ordinary differential equations and difference equations. Stochastic modeling, and numerical solution of stochastic differential equations. 3606: Concepts and techniques from numerical linear algebra, including iterative methods for solving linear systems and least squares problems, and numerical approaches for solving eigenvalue problems. Ill-posed inverse problems such as parameter estimation, and numerical methods for computing solutions to inverse problems. Numerical optimization. Emphasis on large-scale problems.
Prerequisite(s): (CS 1114 or CS 1064 or MATH 1454) and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 3606 - Mathematical Modeling: Methods and Tools (3 credits)
3605: Mathematical modeling with ordinary differential equations and difference equations. Numerical solution and analysis of ordinary differential equations and differencee equations. Stochastic modeling and numerical solution of stochastic differential equations. 3606: Concepts and techniques from numerical linear algebra, including iterative methods for solving linear systems and least squares problems, and numerical approaches for solving eigenvalue problems. III-posed inverse problems such as parameter estimation, and numerical methods for computing solutions to inverse problems. Numerical optimization. Emphasis on large-scale problems.
Prerequisite(s): CMDA 3605
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 3634 - Computer Science Foundations for Computational Modeling & Data Analytics (3 credits)
Survey of computer science concepts and tools that enable computational science and data analytics. Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3634

CMDA 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3654, STAT 3654

CMDA 4274 - Sports Analytics Statistical Research (3 credits)
Statistical analysis of sports data. Game performance statistics and expected scores. Analysis of player performance, player tracking, team performance, and sports betting. Bayesian methods and prediction models applied to sports data. Decision-making. Assessing sports analytics research and literature.
Prerequisite(s): (STAT 4214 and STAT 4444) or (CMDA 4654 or CS 4654 or STAT 4654) or (STAT 3274 or CMDA 3274)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4274

CMDA 4314 - Big Data Economics (3 credits)
Applied econometrics dealing with big data. Theoretical, computational, and statistical underpinnings of big data analysis. The use of econometric models and deep machine learning algorithms to analyze the high-dimensional data sets. Implications in research focusing on economic questions that arise from rapid changes in data availability and computational technology. Materials are hands-on tutorials that come with Python codes and real-world data sets.
Prerequisite(s): ECON 3254 or ECON 4304 or CMDA 3654 or STAT 3006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4314

CMDA 4604 - Intermediate Topics in Mathematical Modeling (3 credits)
Introduction to partial differential equations, including modeling and classification of partial differential equations. Finite difference and finite elements methods for the numerical solution of partial differential equations including function approximation, interpolation, and quadrature. Numerical solution of nonlinear systems of equations. Uncertainty quantification, prediction.
Prerequisite(s): CMDA 3606
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4634 - Scalable Computing for Computational Modeling and Data Analytics (3 credits)
A focused study of concepts and tools that accelerate computational and data science at scale. Design, analysis, optimization, and modeling of application-driven algorithms suitable for state-of-the-art scalable computing platforms. Software development and engineering for scalable computational science.
Prerequisite(s): (CMDA 3634 or CS 3634 or CS 4234) and (CMDA 3654 or CS 3654 or STAT 3654) and (CMDA 3605 or CS 3414 or MATH 3414 or MATH 4445)
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706) and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4654, STAT 4654

CMDA 4664 - Computational Intensive Stochastic Modeling (3 credits)
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models.
Prerequisite(s): (STAT 4106 or CMDA 3605) and (CS 1114 or CS 1064 or STAT 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4664

CMDA 4864 - Computational Modeling and Data Analytics Capstone Project (3 credits)
Capstone research project for Computational Modeling and Data Analytics majors. Cultivates skills including reviewing the literature, creative problem solving, teamwork, critical thinking, and oral, written, and visual communications. Quantitative and computational thinking, informed throughout by ethical reasoning.
Prerequisite(s): CMDA 3605 and CMDA 3634 or CS 3634 and CMDA 3654 or CS 3654 or STAT 3654
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Computer Science (CS)

CS 1014 - Introduction to Computational Thinking (3 credits)
An exploration of basic ideas of computational thinking focusing on the perspectives, thought processes, and skills that underlie computational approaches to problem formulation and problem solving. Applications of computational tools to investigate complex, large-scale problems in a variety of knowledge domains. Basic introduction to algorithms and a practical programming language. Examination of the societal and ethical implications of computational systems.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1044 - Introduction to Programming in C (3 credits)
Fundamental concepts underlying software solutions of many problems. Structured data, statement sequencing, logic control, input/output, and functions. The course will be taught using a structured approach to programming. Partially duplicates 1344.
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1054 - Introduction to Programming in Java (3 credits)
An introduction to object-oriented programming using the Java language. Fundamental concepts underlying programming and software solutions to many problems. Structured data, statement sequencing, logic control, classes, objects, methods, instantiation of classes, sending messages to objects. The impact of computing on issues of diversity and inclusion.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1064 - Introduction to Programming in Python (3 credits)
Introduction to programming in Python contextualized with scientific and engineering problems. Computational problem-solving skills and software solutions in addition to Python language fundamentals. The basics of control flow with loops and conditionals, state tracing and manipulation, simple and complex types, organization of code using functional and object-oriented coding strategies, and data processing. Create, interpret, and debug programs. Ethically debate important issues in computing culture.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1114 - Introduction to Software Design (3 credits)
Fundamental concepts of programming from an object-oriented perspective. Basic software engineering principles and programming skills in a programming language that supports the object-oriented paradigm. Simple data types, control structures, array and string data structures, basic algorithms, testing and debugging. A basic model of the computer as an abstract machine. Modeling and problem-solving skills applicable to programming at this level. Partially duplicates 1054, 1124, and 1705.
Corequisite(s): MATH 1225
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

CS 1944 - Computer Science First Year Seminar (1 credit)
An introduction to academic and career planning for computer science majors.
Prerequisite(s): CS 1114 or CS 2064 or ECE 2514
Instructional Contact Hours: (1 Lec, 1 Crd)

CS 2064 - Intermediate Programming in Python (3 credits)
Advanced uses of control flow and data processing, data structures, computational techniques, object-oriented programming, and modern data science pipelines. Creating, interpreting, and debugging complex programs. Problems and projects contextualized for scientists and engineers. Implementation of Python programs in data science and production environments, production of object-oriented solutions to complex problems, and ethical implications of technological change.
Prerequisite(s): CS 1064
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2104 - Introduction to Problem Solving in Computer Science (3 credits)
This course introduces the student to a broad range of heuristics for solving problems in a range of settings that are relevant to computation. Emphasis on problem-solving techniques that aid programmers and computer scientists. Heuristics for solving problems in the small (classical math and word problems), generating potential solutions to real-life problems encountered in the profession, problem solving through computation, and problem solving in teams.
Prerequisite(s): (MATH 1205 or MATH 1225 or MATH 1526) and (CS 1114 or CS 2064 or ECE 2514)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2114 - Software Design and Data Structures (3 credits)
A programming-intensive exploration of software design concepts and implementation techniques. Builds on knowledge of fundamental object-oriented programming. Advanced object-oriented software design, ethics in computing, algorithm development and analysis, and classic data structures. Includes a team-based software project.
Prerequisite(s): CS 1114 or CS 2064
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CS 2144 - Competitive Problem Solving I (3 credits)
Fundamentals of algorithms, data structures, and implementation techniques, taught in a setting that combines collaborative practice with competitive exercise. Students practice to solve problems using a computer, which are judged by automated evaluation software for correctness and efficiency. Practice with data structures including arrays, lists, maps, and trees, as well as algorithmic strategies including recursion, divide-and-conquer, dynamic programming, search and traversal algorithms, graph representations, and computational geometry. Macro- and micro optimization techniques to improve efficiency are emphasized.
Prerequisite(s): CS 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 2164, PSCI 2164

CS 2304 - Topics in Programming Systems (1 credit)
Guided self-study in a specific programming system, its syntax and applications. Based on prior knowledge of the programming process and experience in programming with some high-level language. Systems include JavaScript, C++, CUDA, Ruby, SQL, FORTRAN, UNIX, etc. May be taken three times for credit with different system each time. May be taken only twice for CS major or minor credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

CS 2505 - Introduction to Computer Organization (3 credits)
An introduction to the design and operation of digital computers. Works up from the logic gate level to combinational and sequential circuits, information representation, computer arithmetic, arithmetic/logic units, control unit design, basic computer organization, relationships between high level programming languages and instruction set architectures. A grade of C or better is required in CS prerequisite. Corequisites: MATH 2534 or MATH 3034.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2506 - Introduction to Computer Organization (3 credits)
An introduction to the design and operation of digital computers. Instruction formats and construction, addressing modes, instruction execution, memory hierarchy operation and performance, pipelining, input/output, and the relationships between high level programming languages and machine language. A grade of C or better is required in CS pre-requisite 2505 and 2114.
Prerequisite(s): (CS 2114 or ECE 3514) and (CS 2505 or ECE 2564) and (MATH 2534 or MATH 3034)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2984E - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

CS 3114 - Data Structures and Algorithms (3 credits)
Advanced data structures and analysis of data structure and algorithm performance. Sorting, searching, hashing, and advanced tree structures and algorithms. File system organization and access methods. Ethical issues in the context of data analysis and software performance. Course projects require advanced problem-solving, design, and implementation skills.
Prerequisite(s): (CS 2114 or ECE 3514) and (CS 2505 or ECE 2564) and (MATH 2534 or MATH 3034)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3214 - Computer Systems (3 credits)
Introduction to computer systems as they are relevant to application programmers today, with emphasis on operating system principles. Operating system design and architectures; processes; threads, synchronization techniques, deadlock; CPU scheduling; system call interfaces, system level I/O and file management; shell programming; separate compilation, loading and linking; inter-process communication (IPC); virtual and physical memory management and garbage collection; network protocols and programming; virtualization; performance analysis and optimization. A grade of C or better is required in CS pre-requisites 2506 and 2114.
Prerequisite(s): (CS 2506 and CS 2114) or (ECE 2564 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3274 - Software Reverse Engineering (3 credits)
Theory and practice of software reverse engineering, static and dynamic analysis techniques and tools, reverse engineering of malware, obfuscated binaries, communications and command and control analysis, reverse engineering of non-binary software.
Prerequisite(s): (CS 2114 and CS 2506) or (ECE 2534 and ECE 3514)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3304 - Comparative Languages (3 credits)
This course in programming language constructs emphasizes the run-time behavior of programs. The languages are studied from two points of view: (1) the fundamental elements of languages and their inclusion in commercially available systems; and (2) the differences between implementations of common elements in languages. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3314 - Programming Language Theory and Practice (3 credits)
Theoretical basis of programming languages, including formal languages, computability theory, type theory, and programming language design. Standard syntax notations. Fundamental programming language features for control flow and data representation. Language implementation strategies. Unsolvable problems in the context of programming languages and computing.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3414 - Numerical Methods (3 credits)
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and MATH 4404.
Prerequisite(s): (CS 1044 or CS 1705 or CS 1114 or CS 1124) and MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204H or MATH 2204)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MATH 3414

CS 3604 - Professionalism in Computing (3 credits)
Studies the ethical, social, and professional concerns of the computer science field. Covers the social impact of the computer, implications and effects of computers on society, and the responsibilities of computer professionals in directing the emerging technology. The topics are studied through case studies of reliable, risk-free technologies, and systems that provide user friendly processes. Specific studies are augmented by an overview of the history of computing, interaction with industrial partners and computing professionals, and attention to the legal and ethical responsibilities of professionals. This is a web-supported course, incorporating writing intensive exercises, making extensive use of active learning technologies. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 1944 and (CS 2114 or ECE 3514) and (COMM 2004 or COMM 2014)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3634 - Computer Science Foundations for Computational Modeling & Data Analytics (3 credits)
Survey of computer science concepts and tools that enable computational science and data analytics. Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3634

CS 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3654, STAT 3654

CS 3704 - Intermediate Software Design and Engineering (3 credits)
Explores the principles of software design in detail, with an emphasis on software engineering aspects. Includes exposure of software lifecycle activities including design, coding, testing, debugging, and maintenance, highlighting how design affects these activities. Peer reviews, designing for software reuse, CASE tools, and writing software to specifications are also covered. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3714 - Mobile Software Development (3 credits)
Technologies and concepts underlying software development for mobile devices (handheld computers). Mobile computing platforms, including architecture, operating system, and programming environment. Software design patterns and structuring for mobile applications. Network-centric mobile software development. Data persistence. Programming for mobile device components such as cameras, recorders, accelerometer, gyroscope and antennas. Location-aware software development. A grade of C or better required in CS prerequisite.
Prerequisite(s): CS 2114 or ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3724 - Introduction to Human-Computer Interaction (3 credits)
Survey of human-computer interaction concepts, theory, and practice. Basic components of human-computer interaction. Interdisciplinary underpinnings. Informed and critical evaluation of computer-based technology. User-oriented perspective, rather than system-oriented, with two thrusts: human (cognitive, social) and technological (input/output, interactions styles, devices). Design guidelines, evaluation methods, participatory design, communication between users and system developers. A grade of C or better required in CS prerequisite 2114.
Prerequisite(s): CS 1114 or CS 1044 or CS 1054 or CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3744 - Introduction to GUI Programming and Graphics (3 credits)
Design and implementation of object-oriented graphical user interfaces (GUI) and two-dimensional computer graphics systems. Implementation methodologies including callbacks, handlers, event listeners, design patterns, layout managers, and architectural models. Mathematical foundations of computer graphics applied to fundamental algorithms for clipping, scan conversion, affine and convex linear transformations, projections, viewing, structuring, and modeling. A grade of C or better is required in CS pre-requisite 2114.
Prerequisite(s): (CS 2114 or ECE 3514) and (MATH 1114 or MATH 2114) and (MATH 1224 or MATH 2204)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3754 - Cloud Software Development (3 credits)
Fundamentals of cloud software development, including design patterns, application programming interfaces, and underlying middleware technologies. Development of distributed multi-tiered enterprise software applications that run on a server computer and are accessed using a web browser over the Internet on a network-connected computer such as desktop, laptop, or handheld computer (tablet, smartphone, or mobile device. A grade of C or better is required in prerequisite.
Prerequisite(s): CS 2114 or ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3824 - Introduction to Computational Biology and Bioinformatics (3 credits)
Introduction to computational biology and bioinformatics (CBB) through hands-on learning experiences. Emphasis on problem solving in CBB. Breadth of topics covering structural bioinformatics; modeling and simulation of biological networks; computational sequence analysis; algorithms for reconstructing phylogenies; computational systems biology; and data mining algorithms. Pre-requisite: Grade of C or better in CS 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4014 - Algorithms & Society (3 credits)
This course focuses on social perspectives of algorithms and implications to factors such as class, gender, race, ethnicity, geography, and disability status. Students will be guided to think critically about the impacts of computing in society, as well as the role of social values in their design. Topics will focus on computing technologies involved in critical contemporary and global concerns including machine learning, privacy, and the infrastructure that describes the social and technical context for algorithms. Pre: Junior Standing
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4014

CS 4104 - Data and Algorithm Analysis (3 credits)
Data structures and algorithms from an analytical perspective. Theoretical analysis of algorithm efficiency. Comparing algorithms with respect to space and run-time requirements. Analytical methods for describing theoretical and practical bounds on performance. Constraints affecting problem solvability. A grade of C or better is required in CS prerequisite 3114.
Prerequisite(s): CS 3114 and (MATH 3034 or MATH 3134)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4114 - Introduction to Formal Languages and Automata Theory (3 credits)
The course presents a study of formal languages and the correspondence between language classes and the automata that recognize them. Formal definitions of grammars and acceptors, deterministic and nondeterministic systems, grammar ambiguity, finite state and push-down automata, and normal forms will be discussed.
Prerequisite(s): MATH 3134 or MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4124 - Theory of Computation (3 credits)
Theoretical analysis of the computational process; fundamental concepts such as abstract programs, classes of computational machines and their equivalence, recursive function theory, unsolvable problems, Churchs thesis, Kleenes theorem, program equivalence, and generability, acceptability, decidability will be covered.
Prerequisite(s): MATH 3134 or MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4134 - Quantum Computation and Information Processing (3 credits)
Quantum states and quantum phenomena. Quantum communication concepts such as superdense coding, teleportation, and complexity. Classical and quantum circuits and gate sets for computation. Quantum algorithms and comparison to classical algorithms. Quantum computational complexity theory and complexity classes. Quantum information concepts such as density operators, measurements, and quantum channels. Error correction, the stabilizer formalism, and fault-tolerance. The adiabatic theorem and adiabatic quantum computation. Entanglement and entanglement measures.
Prerequisite(s): MATH 2114 or MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4144 - Competitive Problem Solving II (3 credits)
Deeper treatment of advanced algorithms, data structures, and implementation techniques, taught in a setting that combines collaborative practice with competitive exercise. Students practice to solve problems using a computer, which are judged by automated evaluation software for correctness and efficiency. Practice with advanced searching and graph algorithms, advanced dynamic programming, linear programming techniques, computational geometry, and numerical algorithms. Problems are drawn from multiple areas in computer science. Macro- and micro optimization techniques to improve efficiency are emphasized.
Prerequisite(s): CS 2114 and CS 2144
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4164, PSCI 4164

CS 4204 - Computer Graphics (3 credits)
Hardware and software techniques for the display of graphical information. 2D and 3D geometry and transformations, clipping and windowing, software systems. Interactive graphics, shading, hidden surface elimination, perspective depth. Modeling and realism.
Prerequisite(s): CS 3744
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4214 - Simulation and Modeling (3 credits)
Overview of discrete-event digital computer simulation and modeling. Fundamentals of model development, Monte Carlo simulation, the life cycle of a simulation study, input and output data analysis, world views and time control, random number and variate generation, credibility assessment of simulation results, simulation languages, applications of simulation using the General Purpose Simulation System (GPSS). A grade of C or better required in CS prerequisite 2114.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4224 - Linux Kernel Programming (3 credits)
Design and internal organization of the Linux operating system kernel. Kernel subsystems, boot process, memory management, process and thread model, scheduling, interrupt and exception handling, virtual file system and the concrete file system, block I/O and I/O scheduler, network stack, and device drivers. Modification of existing kernel code. Design, implementation, test and evaluation of new kernel modules. Kernel and full software stack debugging techniques, and virtualization as an aid for operating system development and debug. Software engineering techniques to analyze, modify and run a large, complex open-source code base.
Prerequisite(s): ECE 3574 or CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4414

CS 4234 - Parallel Computation (3 credits)
Survey of parallel computer architectures, models of parallel computation, and interconnection networks. Parallel algorithm development and analysis. Programming paradigms and languages for parallel computation. Example applications. Performance measurement and evaluation. A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4244 - Internet Software Development (3 credits)
Key technology underlying the World-Wide Web. Web architecture, including client and server design, network protocols, and related standards. Static and dynamic content, caching, state management, fault tolerance, error handling. Programming systems and abstractions, e.g., sockets, remote procedures, Web services, frameworks and component models. Document representations and processing. Security. Entrepreneurial issues and emerging technologies. A grade of C or better required in CS 3214 prerequisite.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4254 - Computer Network Architecture and Programming (3 credits)
Introduction to computer network architecture, and methods for programming network services and applications (e.g. DNS, Email and MIME, http, SNMP, multimedia). Wired, wireless, and satellite network architectures. OSI protocol model, with an emphasis on upper layers. Congestion control, quality of service, routing. Internet protocol suite (e.g. IP, TCP, ARP, RARP). Server design (e.g. connectionless, concurrent). Network programming abstractions (e.g. XDR, remote procedure calls, sockets, DCOM). Case studies (e.g. TELNET). A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4264 - Principles of Computer Security (3 credits)
Survey of computer problems and fundamental computer security design principles and models for software systems. Cryptographic models and methods. Modern cyber security techniques for robust computer operating systems, software, web applications, large-scale networks and data protection. Privacy models and techniques. Contemporary computer and network security examples. A grade of C or better is required in prerequisites.
Prerequisite(s): CS 3214 or (ECE 3504 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4274 - Secure Computing Capstone (3 credits)
Advanced topics in cybersecurity and secure computing. Threat modeling through identification and analysis of security threats. Reasoning about the efficacy, complexity, cost, and ethical tradeoffs of computer security systems. Team-based approach to solving open-ended computer security problems. Designing, implementing, documenting, and presenting advanced computer systems.
Prerequisite(s): CS 3114 and CS 3214
Corequisite(s): CS 4264
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4284 - Systems & Networking Capstone (3 credits)
Advanced topics in computer systems & networking, e.g. distributed and parallel processing, emerging architectures, novel systems management & networking design, fault- tolerance, and robust and secure data management. Team- based approach to solving open-ended computer systems & networking problems. Designing, implementing and documenting advanced computer/networking systems. A grade of C or better required in CS prerequisites.
Prerequisite(s): CS 3114 and CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4304 - Compiler Design and Implementation (3 credits)
This course includes the theory, the design, and the implementation of a large language translator system. Lexical analysis, syntactic analysis, code generation, and optimization are emphasized. A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4414 - Issues in Scientific Computing (3 credits)
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006) and MATH 3214 and (CS 1114 or MATH 1454)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: MATH 4414

CS 4504 - Computer Organization (3 credits)
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahls Law, Flynns Taxonomy. A grade of C or better required in prerequisites.
Prerequisite(s): ECE 2500 or CS 3214 or ECE 3504
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4504

CS 4570 - Wireless Networks and Mobile Systems (3 credits)
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects.
Prerequisite(s): CS 4254 or ECE 4564
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4570

CS 4604 - Introduction to Data Base Management Systems (3 credits)
Emphasis on introduction of the basic data base models, corresponding logical and physical data structures, comparisons of models, logical data design, and data base usage. Terminology, historical evolution, relationships, implementation, data base personnel, future trends, applications, performance considerations, data integrity. Senior standing required. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4624 - Multimedia, Hypertext and Information Access (3 credits)
Introduces the architectures, concepts, data, hardware, methods, models, software, standards, structures, technologies, and issues involved with: networked multimedia information and systems, hypertext and hypermedia, networked information videoconferencing, authoring/electronic publishing, and information access. Coverage includes how to capture, represent, link, store, compress, browse, search, retrieve, manipulate, interact with, synchronize, perform, and present: text, drawings, still images, animations, audio, video, and their combinations (including in digital libraries).
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4634 - Design Of Information (3 credits)
Survey of the higher-order properties that allow data to become information, that is, to inform people. The course focuses on the analysis of user needs, user comprehension and local semantics; the design of information organization; and the design of information display appropriate to use and setting. A grade of C or better is required in CS prerequisites 3114 and 3724.
Prerequisite(s): CS 3114 and CS 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4644 - Creative Computing Studio (3 credits)
Capstone computer science course at the intersection of arts and technology. Intensive immersion in different approaches to digital arts such as game design, interactive art, digital music, and immersive virtual reality. Students work in teams to conduct an end-to-end integrative design project. A grade of C or better is required in prerequisite CS 3724.
Prerequisite(s): CS 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regulations, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4654, STAT 4654

CS 4664 - Data-Centric Computing Capstone (3 credits)
Advanced, project-based course on deriving valuable insights from real-world data collected from a variety of sources. Team-based end-to-end projects explore the entire data science workflow: problem statement, formulating the research questions, collecting preparing and cleaning data, alternating between analyzing data and interpreting results, and synthesizing results into a written report and an interactive executable codebase.
Prerequisite(s): CS 3114 and CS 3654 or CMDA 3654 or STAT 3654
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4704 - Software Engineering Capstone (3 credits)
Senior project course integrating software engineering knowledge and skills acquired in previous courses. Team- based approach to problem formulation, requirements engineering, architecture, design, implementation, integration, documentation and delivery of software system that solves a real-world problem. Pre: A grade of C or better in CS 3704.
Prerequisite(s): CS 3704 or CS 3714 or CS 3754
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

CS 4774 - Human-Computer Interaction Design Experience (3 credits)
Project-based design course in human-computer interaction. Team-based, end-to-end, integrative interface design project drawn from interdisciplinary areas of student expertise, e.g., virtual reality, augmented reality, embodied cognition, visualization, semiotic engineering, game design, personal information management, mobile computing, design tools, educational technology, and digital democracy. Not for CS major credit. Senior standing.
Prerequisite(s): CS 3724 and (HIST 2604 or SOC 2604 or STS 2604) and COMM 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4784 - Human-Computer Interaction Capstone (3 credits)
Advanced, project-based course in Human-Computer Interaction. Team-based, end-to-end, integrative interface design project drawn from area of expertise in the department, e.g., virtual reality, augmented reality, embodied cognition, visualization, semiotic engineering, game design, personal information management, mobile computing, design tools, educational technology, and digital democracy. Pre-requisite: Senior Standing required. A grade of C or better is required in CS pre-requisite 3724 and 3744
Prerequisite(s): CS 3724 and CS 3744
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4804 - Introduction to Artificial Intelligence (3 credits)
Overview of the areas of problem solving, game playing, and computer vision. Search trees and/or graphs, game trees, block world vision, syntactic pattern recognition, object matching, natural language, and robotics. Senior standing required. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4824 - Machine Learning (3 credits)
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites.
Prerequisite(s): (ECE 3514 or CS 2114) and (STAT 3704 or STAT 4105 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4424

CS 4884 - Computational Biology and Bioinformatics Capstone (3 credits)
Advanced topics in computational biology and bioinformatics (CBB). Team-based approach to solving open-ended problems in CBB. Projects drawn from areas of expertise in the department, e.g., algorithms for CBB, computational models for biological systems, analysis of structure-function relationships in biomolecules, genomic data analysis and data mining, computational genomics, systems biology. Design, implementation, documentation and presentation of solutions. A grade of C or better required in CS prerequisite 3824.
Prerequisite(s): CS 3824
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4894 - Special Topics in Computer Science (3 credits)
Advanced undergraduate topics in the design, development, use, and impact of computer science solutions or software systems. Topics may include blockchain systems, DevOps, new programming languages, social media software, software as a service, micro-services, and end user programming systems. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): CS 2114 and CS 2505
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CS 4944 - Seminar (1 credit)
Prerequisite(s): CS 3604
Instructional Contact Hours: (1 Lec, 1 Crd)

CS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Construction Engineering & Mgt (CEM)

CEM 1974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 2104 - Introduction to Construction Engineering and Management (3 credits)
Overview of the construction engineering and management profession specialty areas. Introduction to the undergraduate program of study. Fundamentals of effective oral, written and visual communication skills. Professionalism, ethics, and legal issues relating to the industry. Contemporary issues facing the industry. Engineering library resources. Project drawings, computer aided design (CAD), and responding to Requests for Proposals (RFPs).
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2404 - Construction Project Documents (1 credit)
Interpret design documents for construction projects. Analyze project documents to select appropriate construction engineering methods. Quantify materials using appropriate methods and technology. Review and comparison of construction documentation in various industry sectors. Identify information required for construction that is missing or ambiguous in the design documentation. Create and analyze a request for information (RFI) to modify and update the project documentation.
Corequisite(s): CEM 2104
Instructional Contact Hours: (3 Lab, 1 Crd)

CEM 2714 - Construction Safety Systems (3 credits)
Introduction to construction safety and the importance of safety, health, and wellness in the construction industry. Identify systematic safety issues and safety management systems, evaluation of safety systems through MEAD (MacroErgonomic Analysis and Design) methodology to recommend safety management systems to improve safety outcomes on construction operations. Assess health, safety, and wellness initiatives for construction worker safety and well-being. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2824 - Construction Site Analysis (3 credits)
Geospatial information, Global Positioning Systems (GPS), surveying, and aerial photography for condition assessment, solving construction engineering problems, and managing construction control processes. Topographic survey methodology for field layout and stakeout processes in construction. Geospatial data collection techniques for construction risk analysis. Document existing site conditions. Use of software, and custom program tools. Individual and team projects and presentations.
Corequisite(s): 2104 or BC 1224 or CEE 2834.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CEM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 3024 - Construction Estimating and Scheduling (3 credits)
Introduction to estimating and scheduling of construction operations using construction documents. Quantity takeoff, resource and crew enumeration, network logic, activity durations, Critical Path Method (CPM) and Location-Based Management System (LBMS). Bid assembly with markups. Construction decisions based on ethical principles. A grade of C- or better is required in prerequisite.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3064 - Intro to Lean Construction (3 credits)
Introduction to Lean Construction thinking, principles, and practices, definitions, history, theory, and fundamentals related to project production systems. Operating system, organization practices, commercial terms. Pull planning and Last Planner System, teh Big Room concept, and Integrated Form of Agreement (IFOA). Conventional Lean practices A3 problem solving, 5 Whys Root Cause Analysis, and 5s Methadology. Continuous improvement, respect for people, elimination of waste, reducing variability and increasing plan reliability.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3074 - Global Design and Construction for Sustainable Development (3 credits)
A collaborative approach for applying engineering systems and design to global issues. Design, engineering, and construction focused on social responsibility in the global village. Multi-disciplinary teamwork requiring identification of client needs and design considerations, development of site layouts, selection of resources, management of schedule, cost, materials, personnel, quality, and jobsite safety. Applied conflict handling skills and self-reflection on social responsibility, service, intercultural global awareness, and evaluating the success of sustainable projects. May be repeated one time with different content for a maximum of six credits. Multi-day field trip required. Pre: Junior Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CEM 3084 - Construction Economy (3 credits)
Engineering economics, accounting, finance, and entrepreneurship. Construction financial management and financial decision-making. Construction financial risk, estimation, and generation of financial statements. Construction company creation and business plan development. Assessment of construction project delivery methods and impacts of retainage, bonding, and taxation.
Prerequisite(s): CEM 2104 or BC 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 3134

CEM 3154 - Smart Construction (3 credits)
Introduction to smart construction, definitions, principles and practices. Exploration of inefficiencies associated with the traditional approaches to construction. Intelligence requirements of the building lifecycle. Smart planning and contracting practices, and facilitating technologies. Smart design principles, techniques, technologies, strategies for involving down-stream stakeholders in the design of buildings for constructability and maintainability. Overview of digital infrastructure, types, selection and role in integrating the design and construction phases.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3164 - Construction Health and Safety (3 credits)
Introduction to fundamentals of Occupational Health and Safety (OHS) for the construction industry. History of OHS regulation and specific governmental regulations, standards and laws. Health, safety, and environmental hazards identification. Methods of quantifying exposure and estimating risk. Design and prioritization of control solutions to mitigate hazards. Contemporary issues and theoretical frameworks in the field of OHS management relevant to the industry. Prevention through Design, behavior-based safety, different construction project delivery methods, safety climate and culture, control banding, and systems safety.
Corequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3714 - Controlling Construction Safety Hazards (3 credits)
Perceive, recognize (cognitive recall), and examine/classify (decision making) construction safety hazards and their underlying energy sources. To control hazards, the construction hierarchy of controls guides a safety by design methodology. Accident investigation or forensic processes using design-based arguments to determine root causes of incidents. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4024 - Construction Law and Contract Administration (3 credits)
Application of contract law, torts, and statutory law in construction. Legal context, parties, interpreting contracts and specifications, contract changes, differing site conditions, delays, disruptions, and acceleration. Dispute avoidance and resolution. Ethics and risk management. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4314 - Design of Wood Structures (3 credits)
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls.
Prerequisite(s): SBIO 3314 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 4314

CEM 4445 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3024
Corequisite(s): CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4446 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3084 and CEM 4445 and CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4624 - Construction Robotics and Automation (3 credits)
Automation and its application in construction. Automated problem-solving methodologies in Building Information Modeling (BIM) and data interoperability solutions. Robotics and the application of robotic technologies in construction considering safety and technical operation requirements in construction environments and robot programming and controls. Unmanned Aerial Vehicles (UAVs) or drones in construction projects. Emerging areas of research in the field of construction automation and robotics. No programming background is required.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4634 - Data Analysis and Visualization for Construction and Facilities Management (3 credits)
Introduction to data analysis and visualization theories and techniques applied in the construction and facilities management domain. Data collection, processing, storage, analysis, and visualization methods in the context of construction and building management. Data-driven decision making.
Prerequisite(s): (CEM 2104 or BC 2024 or CEE 3014) and (BC 2114 or CEE 3804)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4644 - Artificial Intelligence for Design, Construction, and Operations (3 credits)
Evaluate the basic concepts and computational tools of artificial intelligence (AI), machine learning, and deep learning in the architecture, engineering, and construction (AEC) industry. Appraise the history and potential to improve automation, digitalization, and diversity and inclusion in the industry. Develop practical expertise in formulating, deploying, and evaluating deep learning models, including convolutional neural networks, pretrained computer vision models, sequential models, and generative AI, through hands-on projects such as infrastructure health monitoring, safety management, and building energy consumption prediction. Foster real-world application of knowledge through project-based learning.
Prerequisite(s): (MATH 2114) and (ENGE 1215 or CS 1014 or ENGE 1414 or CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4714 - Construction Safety Culture (3 credits)
Examination of construction safety culture and climate and the role of organizational leadership in ethical safety practices. Analyze safety cultures within the construction industry for recommendations of change to shape safety practices.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4724 - Construction Industry Futures: Safety, Health, and Wellness (3 credits)
Evaluate the future of the construction industry dynamics (trends, drivers, and disruptors) relative to their impacts on safety, health, and wellness. Compare global construction safety performances and practices. Design adaptable safety, health, and well-being management systems of the future based on technology-human interfaces, climate change, and globalization in construction.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Consumer Studies (CONS)

CONS 2304 - Consumer and Family Finances (3 credits)
Overview of consumer and family finances, including budgeting, goal setting, cash management, credit, insurance, taxes, housing, investment alternatives, and retirement plans. Fundamental tools for financial decision making through the coverage of time value of money, calculations for consumer loans, and tools for financial decisions across the lifecycle. Explore ethical issues surrounding financial decisions.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2974H - Indepdendent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 3404 - Consumer Education Strategies (3 credits)
Analysis of the role of effective consumer education strategies in consumer decision-making. Planning, developing, testing, and evaluating consumer education programs using a variety of strategies, including social marketing, for selected community partners and operating the Consumer Education Laboratory.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

CONS 3504 - Resource Management for Individuals and Families (3 credits)
Introduction to resource management concepts and theories with application to personal and family life goals. Discussion of values, goals, decision making, planning, and communication in relation to the management process. Application of the management process to the use of resources, time, finances, stress, and the environment.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4304 - Advanced Consumer Family Finances (3 credits)
Advanced financial topics for consumers and families. Identification of employee benefit components including health care, incentive plans, insurance, and retirement. Analysis of consumers insurance needs. Discussion and comparison of retirement and investment tools used by consumers, including public and private retirement components. Interpretation of research directions and policy influences related to employee benefits, insurance, investments, and retirement saving. Investigation of special topics in retirement. Pre: Senior Standing.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4314 - Debtor-Creditor Relationships (3 credits)
Examination of legal and operational aspects of debtor-creditor relationship from the perspective of businesses and debtors. Overview of the types of credit, access to credit, factors contributing to debt problems, and alternatives available for resolution. Focus on collection processes of federal and state bankruptcy laws and regulations.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4324 - Financial Counseling (3 credits)
Examination of debt and budgeting problems affecting families. Utilizes a problem-solving approach. Includes financial counseling strategies for coping with financial crises and becoming proactive in family financial management.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4404 - Consumer Protection (3 credits)
Analysis of the effectiveness of consumer protection efforts. Examination of government laws, regulations, and agencies at the federal, state, and local levels, as well as the effectiveness of both business and private consumer protection efforts.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4414 - Professionalism in Consumer Affairs (3 credits)
Roles, functions and responsibilites of consumer affairs professionals employed in business, government, and non-profit public/consumer interest organizations. Professional advocacy within employing organizations, managing consumer complaint handling systems and major consumer and career issues are analyzed.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Cooperative Education Program (CEP)

CEP 3084 - University Internship (0 credits)
To be used of Cooperative Education Program - University Internships. No Credit.
Instructional Contact Hours: (0 Crd)

CEP 4084 - Cooperative Education Program (0 credits)
To be used for co-ops in industry. No credit.
Instructional Contact Hours: (0 Crd)

Criminology (CRIM)

CRIM 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: HUM 1054, RLCL 1054

CRIM 2504 - Crime and Punishment in American History (3 credits)
Analyzes changing understandings of crime and punishment from the Colonial Era to the Age of Mass Incarceration. Considers how factors of race, ethnicity, class, and gender intersected with changing ideas of criminality and punishments.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2504

CRIM 2754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 3124 - Murder in American History (3 credits)
Considers how the definition of murder as a crime has changed from the colonial period to the present day. Uses murder cases to study the dynamics of American society in condemning, condoning, or celebrating murder. Asks how cultural factors, including racial prejudice, gender stereotypes, beliefs about sexuality, and class status affected the act of killing, media coverage of the event, societal reactions, and the execution of justice. Topics covered include abortion, lynching, vigilante justice, and the evolution of the legal system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3124

CRIM 3414 - Criminology (3 credits)
Principles of criminology and contemporary theories of criminal behavior, focusing on the extent and distribution of crime in the United States.
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 3434 - Systems of Justice (3 credits)
Analyzes the systems of justice in the United States, from a sociological perspective. Focuses on law enforcement, courts, and corrections. Evaluates the effectiveness of social policies related to systems of justice. Explores the structural, community, and individual level factors that influence different stages of justice systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 3474 - Women and Crime (3 credits)
Focuses on women as victims and perpetrators of crime, with particular attention to race and class. Analyzes how social, cultural, and economic factors influence victimization and participation in crime. Includes adolescent girls involvement with crime, including juvenile gangs. Evaluates theoretical explanations of why women commit crime. Examines womens experiences with the criminal justice system.
Prerequisite(s): CRIM 3414 or SOC 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4224 - Victimology (3 credits)
An in-depth exploration of the multifaceted field of victimology. A scientific study of victims and the aftermath of victimization, which delves into the physical, emotional, and psychological consequences victims endure. Provides insights into the historical context of victim studies, various theoretical frameworks, and the evolving role of the criminal justice system concerning victims' rights and advocacy. Additionally, this course examines the societal consequences of victimization and explores preventive, interventionist, and compensatory mechanisms to support victims and mitigate the impact of crimes.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4224

CRIM 4424 - Juvenile Delinquency (3 credits)
Examination of juvenile delinquency. Includes methods of data collection and the extent and distribution of delinquency. Detailed coverage of theories of delinquent behavior. Examines the juvenile justice system and treatment and prevention of delinquency. Utilizes current empirical research on delinquency in the U.S. and internationally.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4454 - Topics in Criminology (3 credits)
A variable topics course in criminology. In-depth examination of topics such as capital punishment, women and criminology, racial profiling, terrorism, white collar crime, law enforcement, international gangs, political crime, the prison system, cybercrime, and rape. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing.
Prerequisite(s): CRIM 3414 or SOC 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CRIM 4474 - Cyber Criminology (3 credits)
Empirical patterns and consequences of cybercrimes. Emphasis on applying criminological theories of crime and victimization to cyberspace. Cybercrime prevention strategies and tactics. Examination of ethical issues of privacy, security, and social control. Pre: Junior standing.
Prerequisite(s): CRIM 3414 or SOC 3414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4484 - Hate Crimes (3 credits)
Focuses on the causes, manifestations, and consequences of hate crimes in the United States. Includes theories of prejudice and biased behavior, the context of perpetration, the individual and community-level effects on the victims, and the political, historical, and social significance of such crimes. Considers broad questions of bias compared to hate, the recognition and prosecution of hate crimes compared to non-bias crimes, the impacts of hate crimes at the individual and community levels, and responses by law enforcement and communities.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4484

CRIM 4504 - Family and Crime (3 credits)
Focuses on the ways in which involvement in the criminal justice system affects families and family systems. Analyzes the antecedents and consequences of parental incarceration, including an investigation as to how social policies influence this phenomenon. Includes how offenders and their families are embedded in the criminal justice system and learn to navigate periods of incarceration and reentry—which includes family members' secondary prisonization. Examines the emotional and financial costs of incarceration and reentry on families, as families serve as informal safety nets.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

CRIM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Crop and Soil Environmental Science (CSES)

CSES 2224 - Foundations of Precision Agriculture (3 credits)
Integrated technologies in the plant and environmental sciences including: global positioning systems (GPS), geographic information systems (GIS), remote and proximal sensing, variable rate technology (VRT) and decision support systems (DSS). Application to site-specific nutrient, water, weed and disease management.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2244 - Agriculture, Global Food Security and Health (3 credits)
Agriculture and food security within the larger context of applied agronomy, gender role, cultural and political aspects of food production, food policy, production contraints, and global population growth. Emphasis on gender iniquity and globalized food systems will be made. Service learning experience both local and global to promote career opportunity in international development.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2434 - Crop Evaluation (2 credits)
Identification of more than 200 crops, weeds, seeds and crop diseases. Seed testing for purity according to the rules of the Association of Official Seed Analysts. Crops graded according to the official USDA grain grading standards.
Instructional Contact Hours: (6 Lab, 2 Crd)

CSES 2444 - Agronomic Crops (3 credits)
An introduction to crop production in Virginia, presenting basic climatic, crop, and soil characteristics and their relation to cropping systems. Introduces basic mechanical, chemical, and managerial tools of crop production and examines feed quality and seed and forage storage.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2564 - Turfgrass Management (3 credits)
Growth, development, adaptation, and selection of the major turfgrass species. Principles of establishment, mowing, nutrition, irrigation, cultivation, and pest control of lawns and utility turfs.
Corequisite(s): BIOL 1105
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3114 - Soils (3 credits)
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant-and earth-science majors. Partially duplicates 3134.
Prerequisite(s): CHEM 1036
Corequisite(s): CSES 3124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOS 3614

CSES 3124 - Soils Laboratory (1 credit)
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134.
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: GEOS 3624

CSES 3144 - Soil Description and Interpretation (3 credits)
Describing, classifying, evaluating, and interpreting soil and site properties in the class and field. Local field trips supplement lecture and laboratory studies. Required for students interested in attending soil judging contests.
Corequisite(s): CSES 3114, CSES 3124
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

CSES 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3304, GEOS 3304

CSES 3564 - Golf and Sports Turf Management (3 credits)
Principles of turfgrass science and culture required for successful establishment and management of intensely utilized fine golf and sports turf surfaces. Pre: CSES 3564 or equivalent turfgrass science fundamentals course from transfer institution.
Prerequisite(s): CSES 2564
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3614 - Soil Physical and Hydrological Properties (3 credits)
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance.
Prerequisite(s): (CSES 3114 and CSES 3124) or (GEOS 3614 and GEOS 3624)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4064 - Soil Microbiology (3 credits)
Soil microbes as determinants of plant growth, sustainable agricultural systems, and global nutrient cycles. Environmental controls of soil microbes and relationship to soil decomposition. Soil as a micro-habitat. Application to soil management and plant growth, plant-microbe mutualisms, probiotics, biocontrol, composting, ecosystem restoration, and disease suppression.
Prerequisite(s): BIOL 1105 and (CSES 3114 or ENSC 3114 or GEOS 3614) or (CSES 3134 or ENSC 3134)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4134 - Soil Genesis and Classification (3 credits)
Formation of soils across landscapes, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4144 - Plant Breeding and Genetics (3 credits)
Genetic variation in plants and its importance in plant breeding, and comparisons of theories and procedures in breeding of self-pollinated versus cross-pollinated plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4174 - Soil Evaluation and Sampling (3 credits)
Naming, describing, classifying, sampling, and interpreting soil and site properties in the field to assess environmental impacts and suitability under specific land use scenarios. Selecting and evaluating sites of representative soil resources across the landscape using accepted professional protocols, simulating workplace responsibilities and performance. Local and regional field trips and sampling projects provide professional skill development evaluated by practitioners and potential employers.
Prerequisite(s): CSES 3114 or CSES 3144
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4214 - Soil Fertility and Management (3 credits)
Soil productivity and nutrients required for crop growth; fertilizer sources and nutrient reactions in soil; methods of fertilizer nutrient placement in major tillage systems; and interpretation of soil tests and plant analyses for determining crop nutrient requirements.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4224 - Applied Concepts in Precision Agriculture (3 credits)
Advanced applications of core components and technologies used for integrated plant and environmental studies. Global Navigation Satellite Systems (GNSS), remote sensing technologies, Geographic Information Systems (GIS), soil sampling, yield monitoring, and analysis and decision-making systems applied for site specific management of production agriculture resources.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4234 - Agro Data Integration (3 credits)
Data science applications in the agricultural sciences. Data pipelines and modern Linux, cluster and cloud-based computing environments. Command line interface and shell scripting. Programming and data processing in Python programming language. Data analysis and visualization in R programming language. Agronomic data analysis and data mining.
Prerequisite(s): CSES 2224 and CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4324 - Water Quality Laboratory (1 credit)
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314.
Prerequisite(s): CHEM 1046
Corequisite(s): CSES 4314, ENSC 4314
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ENSC 4324

CSES 4334 - Principles and Practice of Agroforestry (3 credits)
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4334

CSES 4344 - Crop Physiology and Ecology (3 credits)
Developmental and ecological processes important in cropping situations: seed physiology, root and canopy development, flowering, water stress, energy flow, competition; emphasis on physiological adaptations, limitations to yield, and yield-optimizing strategies.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4354 - Advanced Agronomic Crops (3 credits)
Survey of major agronomic crops grown in the Eastern US and their production including: corn, soybean, wheat, barley, cotton, peanut, tobacco and alfalfa. Covers impact of environmental conditions and management on crops, resource requirements for productivity, and effects on soil resources.
Prerequisite(s): CSES 2444
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4444 - Managed Ecosystems, Ecosystem Services, and Sustainability (3 credits)
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior Standing required.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENSC 4444

CSES 4524 - Drone Applications in Ag Systems (3 credits)
Unmanned Aerial Systems (UAS) or drones as an advanced remotely sensed technology to collect ultra-high spatial resolution images. Components of drones and sensors. UAS operational concepts, and legal requirements, principles of drone data collection and drone platforms. Overview of data processing software and generation of land maps from drone photogrammetry. Image analysis to make recommendations for water, nutrient and pesticide applications.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4534 - Internet of Things (IoT) for Smart Farming (3 credits)
Internet of Things (IoT) technology in the plant and environmental sciences and applications to smart-farming ecosystems and agricultural industry. IoT platforms and systems used in smart farming programs related to field equipment management, IoT components, data management, and cybersecurity. Applying wireless sensors, controllers, computers, actuators, and software via wireless network devices.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4544 - Forage Crop Ecology (3 credits)
Species adaptation interrelated with soil, climatic, and biotic factors as associated with establishment, production, utilization, and nutritional value of forages.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4644 - Land-based Systems for Waste Treatment (3 credits)
Soils as a medium for waste treatment; potential for environmental degradation from biologicals and chemicals added to soils; development of land-based treatment and utilization systems for solid and liquid wastes; issues and concerns relating to large-scale applications of municipal and industrial wastes to land.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4854 - Wetland Soils and Mitigation (3 credits)
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4864 - Capstone: Crop & Soil Sciences (3 credits)
Experiential and discussion-based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan that is defended orally. Review available careers in the crop and soil sciences. Compose and critique resumes and cover letters. CSS majors only. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Dairy Science (DASC)

DASC 1464 - Dairy Cattle Handling (1 credit)
Safety in dairy cattle handling; animal behavior; care, housing, and managerial practices related to dairy cattle. Experiential activities. Herding, sorting, halter training, health scoring, and milking.
Instructional Contact Hours: (3 Lab, 1 Crd)

DASC 1574 - Dairy Science First Year Experience (1 credit)
The scope of the dairy science undergraduate program, preparation for careers in dairy and related industries. Hands-on experience working with dairy cattle. Inquiry, problem solving, and integration of ideas and experiences with a focus on the dairy industry.
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 2204 - Entrepreneurship in Animal Agriculture (3 credits)
Impact of animal entrepreneurship on the US agricultural economy. Innovative products and services for the dairy and livestock industries. Strategic planning, human resources, production scheduling, marketing, and financial management for animal enterprises. Capital acquisition. Sensitivity analysis for key planning assumptions. Contingency planning and risk management. Identification of non-traditional career paths in the animal industry. Pre: Sophomore Standing.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 2474 - Dairy Science and Industry (3 credits)
Sustainable production, processing, and marketing of milk and milk products domestically and globally. Biology of dairy cattle with emphasis on genetics, reproduction, lactation, and nutrition. Management of dairy herds.
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 2484 - Dairy Cattle Evaluation (2 credits)
Critical appraisal of dairy cattle conformation and experience in linear trait scoring, linear trait relationships to profitability, competitive judging; written and oral justification; organization and conduct of shows and contests; showmanship. II.
Instructional Contact Hours: (6 Lab, 2 Crd)

DASC 2664 - Professional Discourse and Career Development (1 credit)
Emphasis on writing and speaking skills for livestock industry or post-baccalaureate education. Self-marketing, job acquisition, press relations, and conduct of meetings and labor management techniques.
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 3134 - Animal Agriculture and the Environment (3 credits)
Environmental issue associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 3134

DASC 3274 - Applied Dairy Cattle Nutrition (3 credits)
Application of basic principles of nutrition in developing rations for dairy herds. Emphasis is placed on appropriate use of forages, ration formulation techniques, development of profitable rations, and ration delivery.
Corequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 3474 - Dairy Information Systems (3 credits)
Development, function, and use of dairy information systems including computerized performance testing programs for dairy cattle improvement and dairy herd management. Dairy management software applications. Precision dairy farming. Whole herd evaluation. Pre: Junior standing.
Prerequisite(s): DASC 2474
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4174 - Applied Dairy Cattle Genetics (3 credits)
Application of genetic principles to dairy cattle improvement. Setting goals for genetic improvement, characteristics of traits included in selection, current methods of estimating breeding values, the role of artificial insemination and breed associations in genetic improvement, cattle genetics.
Prerequisite(s): ALS 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4274 - Dairy Ration Formulation (1 credit)
Develop entry level professional animal nutritionist skills; use customer and feed databases, use optimization algorithms to formulate least cost diets and feed mixes, simultaneous consideration of diet cost, animal product return, and environmental constraints; further develop intergrative thinking and problem solving skills.
Corequisite(s): DASC 3274
Instructional Contact Hours: (0 Lec, 3 Lab, 1 Crd)

DASC 4304 - Principles and Practices of Bovine Reproduction (2 credits)
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, and ultrasonography. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: APSC 4304

DASC 4374 - Physiology of Lactation (3 credits)
Anatomy of the mammary gland and physiology of lactation in domestic and laboratory mammals with emphasis on dairy cattle. Mammary gland health and factors affecting lactation. Principles and techniques in dairy herd milking management.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 4384 - Mammary Immunology (3 credits)
This course is designed to provide students with basic knowledge of immunology as related to diseases of the mammary gland. Concepts of mammary gland immunity, disease etiology, immunopathology, diagnosis and therapy will be covered with a focus on ungulate species. Host pathogen interactions, solving problems, writing intensive, literature search.
Prerequisite(s): ALS 2304 and ENGL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4474 - Advanced Dairy Management Evaluation (2 credits)
Students will learn to critically evaluate all aspects of dairy farm management on working farms. The assessment and recommendations will be developed using information gathered from herd production records and financial statements, visual observations at the farm, and an interview of the farm owner and workers. Data assessed will include milk, growth, health, reproduction, and culling records; cash flow and profit loss statements; nutrition and nutrient management records; and labor management structure. The assessments and reports will further develop integrative thinking, oral communication, and written communication skills.
Prerequisite(s): DASC 3474 and ALS 3204 and ALS 3304
Corequisite(s): DASC 4475
Instructional Contact Hours: (6 Lec, 0 Lab, 2 Crd)

DASC 4475 - Dairy Enterprise Management (3 credits)
Decision strategies for modern dairy businesses. 4475: Emphasis on relationships of enterprises and techniques for evaluation of business alternatives, efficiency of production, and profit. Use of microcomputer software to support management decisions. 4476: Concentration on herd replacements, personnel, facilities and issues of management associated with rapidly changing national and international markets, environmental regulations, and computer applications. Group projects and hands-on management of university dairy herd.
Prerequisite(s): DASC 2474
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4476 - Dairy Enterprise Management (3 credits)
Decision strategies for modern dairy businesses. 4475: Emphasis on relationships of enterprises and techniques for evaluation of business alternatives, efficiency of production, and profit. Use of microcomputer software to support management decision. 4476: Concentration on herd replacements, personnel, facilities and issues of management associated with rapidly changing national and international markets, environmental regulations, and computer applications. Group projects and hands-on management of university dairy herd. Pre-requisite may be waived with permission of instructor.
Prerequisite(s): (DASC 4475 or AAEC 3454) and DASC 3474
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 4664 - Translating Dairy Science (1 credit)
Analysis and interpretation of peer-reviewed literature in dairy science. Focus on dairy industry issues discussed in social media. Critical reasoning, information synthesis, and oral and written discourse. Paper presentations and discussion. Pre: Senior Standing
Prerequisite(s): DASC 2664
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Dance (DANC)

DANC 2004 - Anatomy for Performers (3 credits)
An experiential course merging the artistic, experiential, and conceptual understanding of the human body, and how all of its elements work together to produce motion and the sense of being. Study of the anatomical structures of the body through an experiential lens of motion and sensory perception. Introduction of the concepts of kinesiology through the study of bone, joint, tissue, muscular, and organ structures. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to practices of equitable embodied identity. Lecture, demonstration, and experience-based partnering work that draw from a variety of somatic traditions including yoga, pilates, Body-Mind Centering, release technique, Alexander and Feldenkrais techniques, Gyrotonic/Gyrokinesis, and mediation. Designed for performers in the arts, athletes, martial artists, or any students wishing to study the body from an experiential lens.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

DANC 2014 - Introduction to Dance History (3 credits)
Survey of dance history as an art form with global scope. Language of dance criticism and dance writing practices. International dance forms and the emergence and development of 20th and 21st century modern and post-modern concert dance in the United States from the confluence of European folk and court dances, ballet, African and Caribbean influences, and other American cultural dynamics. Emphasis on ethical and aesthetic modes of viewing dance performance with attention to issues of gender and sexuality, race and ethnicity, ability, class, and identity.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

DANC 2024 - Introduction to Dance Techniques (3 credits)
Beginner-level studio dance course. Introduction of movement techniques, improvisation/composition, performance, experiential anatomy, and an overview to concepts in dance history. Development of flexibility, strength, coordination, rhythm, and vocabulary in the modern idiom. Concepts of time, space, energy, and choreographic form presented through set movement exercises, improvisation, and a final compositional project. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. May be repeated once with different content for a maximum of 6 credits. Design Lab/Studio.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

DANC 2104 - Moving Body, Moving Mind (3 credits)
Methods of working intentionally towards cultivating optimal brain states. Mind/body practices to develop connections between contemporary neuroscience, movement, and meditative practices. Studies in the intersection of consciousness, movement, and thought. Introduction to yoga, meditation, authentic movement, experiential anatomy, and somatic work. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to the practices of intentional embodiment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2104

DANC 3024 - Intermediate/Advanced Dance Techniques (3 credits)
Intermediate/advanced level course in movement techniques. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. Improvisation/composition, performance, concepts in anatomy/kinesiology, and 21st century contemporary dance forms. Development of flexibility, strength, coordination, rhythm, vocabulary in the modern idiom, and focused study of partnering concepts from a variety of hybrid forms. Concepts of time, space, energy, and choreographic form presented through set movement exercises and two compositional projects. May be repeated 3 times with different content for a maximum of 9 credits. Design/Lab Studio.
Prerequisite(s): DANC 2024
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

Economics (ECON)

ECON 1004 - First Year Experience Seminar (1 credit)
The course focuses on supporting first-year students and first-semester transfer students to build relationships with faculty, upper class mentors, and each other to prepare them to enter a more significantly diverse and interdisciplinary dependent community. The course also focuses on building skills for students to create personal, academic, and career goals. The course also focuses on resume building opportunities for internships, research experiences, and graduate school.
Instructional Contact Hours: (1 Lec, 1 Crd)

ECON 1104 - Economics of Gender (3 credits)
Economic approach to the causes and consequences of male/female gender differences in economic outcomes. Tools in microeconomic analysis and empirical work. Woman, family choices and labor markets. Gender gap in earnings. Employment and wage policies related to women.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 1204 - Economics of Race (3 credits)
Causes and consequences of racial disparities in economic outcomes including education, health, housing, entrepreneurship, and earnings. Tools in microeconomics and statistics as applied to the study of racial issues. Historical and institutional contexts of racial problems. Change in racial gaps across generations. Impact of public policies to address racial discrimination in labor markets. Does not count toward ECON major.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 1214 - Economic History of Diversity and Inclusion (3 credits)
Economic analysis of topics concerning diversity and inclusion. Emphasis on Virginia and surrounding states. Introduction to the basic principles of economic analysis and economic history, with a special emphasis on models of institutional change, economic growth, discrimination, inequality, migration, and indigenous economic systems. Impact of institutions, environment, and technological change on labor markets, asset markets, and standard of living. Consideration of the role of data in understanding diversity and related ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 1214

ECON 2005 - Principles of Economics (3 credits)
2005: Introduction to microeconomics. The economic approach to decision-making. Model of supply and demand. Elasticities. Consumer behavior. Firm behavior under varying industry structures. Sources and consequences of market failure. Costs and benefits of international trade. The role of government in the economy. Economic, ethical, and social ramifications of issues such as pollution, missing information, and income inequality. 2006: Introduction to macroeconomics. The measurement of economic activity. Macroeconomic problems (such as unemployment and inflation). The monetary system. Effects and limitations of monetary and fiscal policies. International economics. Social and ethical issues related to macroeconomic policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2006 - Principles of Economics (3 credits)
2005: Introduction to microeconomics. The economic approach to decision-making. Model of supply and demand. Elasticities. Consumer behavior. Firm behavior under varying industry structures. Sources and consequences of market failure. Costs and benefits of international trade. The role of government in the economy. Economic, ethical, and social ramifications of issues such as pollution, missing information, and income inequality. 2006: Introduction to macroeconomics. The measurement of economic activity. Macroeconomic problems (such as unemployment and inflation). The monetary system. Effects and limitations of monetary and fiscal policies. International economics. Social and ethical issues related to macroeconomic policy.
Prerequisite(s): ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2025H - Honors Principles of Economics (3 credits)
2025H: Microeconomics. Consumer behavior and demand, firm behavior and supply, price determination and market equilibrium under varying industry structure. Applications to labor and financial markets. 2026H: Macroeconomics. Measuring aggregate economic activity, macroeconomic problems (such as unemployment and inflation), the monetary system, effects and limitations of monetary and fiscal policies.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2026H - Honors Principles of Economics (3 credits)
2025H: Microeconomics. Consumer behavior and demand, firm behavior and supply, price determination and market equilibrium under varying industry structure. Applications to labor and financial markets. 2026H: Macroeconomics. Measuring aggregate economics activity, macroeconomic problems (such as unemployment and inflation), the monetary systems, effects and limitations of monetary and fiscal policies.
Prerequisite(s): ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ECON 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 3004 - Contemporary Economic Issues (3 credits)
The economic analysis of current issues and problems. This course may be repeated with different topic.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3024 - Economic Justice (3 credits)
This course explores how different assumptions regarding the basis of claims for access to economic resources lead to different outcomes. Students will explore a variety of theories and examine their own beliefs about economic justice.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3024

ECON 3034 - Economics of Poverty and Discrimination (3 credits)
Poverty and inequality in the United States and around the world. Sources of poverty. Antipoverty policies. Definition, empirical evidence, and causes of discrimination. Emphasis on ethical human behavior and policy analysis.
Prerequisite(s): ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3054 - Introduction to Forecasting (3 credits)
Provides an introduction to data-driven forecasting, with applications in economics and in other disciplines - e.g., political science and climatology. Specification, estimation, and validation of time-series regression models; ethical issues arising in model specification and estimation. Forecasting theory and evaluation.
Prerequisite(s): STAT 3005 or BIT 2405
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3104 - Microeconomic Theory (3 credits)
Theories of demand, production, perfectly and imperfectly competitive price determination, and general market equilibrium. Analytic applications.
Prerequisite(s): ECON 2005 and (MATH 1225 and MATH 1226) or ECON 2005 and (MATH 1025 and MATH 1026)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3134 - Choice and Behavior (3 credits)
Theories of rational choice, utility, and revealed preference. Intertemporal decision problems and choice under uncertainty with applications to insurance and investments. Behavioral regularities and evidence of violations of rational choice theory. Behavioral models that accommodate this behavior. Applications of behavioral models to economic problems, ethical questions, policy, and organization design. Pre: Sophomore standing.
Prerequisite(s): ECON 2005 or BDS 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 3134

ECON 3144 - Economics of Regulation (3 credits)
Economics of regulation with a focus on U.S. laws and institutions. Market structures, mergers, antitrust laws, and anticompetitive behavior, including collusion and monopolization. Economic regulation of price, entry, and output. Incentive regulation and alternatives to regulation. Valuing life and other nonmonetary benefits. Regulation of health, safety, and the environment.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3154 - Managerial Economics (3 credits)
Applications of economic concepts and models to practical issues. Demand analysis, the law of demand, and different approaches to analyzing consumer behavior (elasticity, consumer surplus, and utility theory). Supply analysis, producer behavior, and theories of firms (diminishing returns, price takers and price searchers). Pricing strategies including segmentation, two-part tariffs, collusion, and predatory pricing. Market imperfections and extensions including signaling, adverse selection, network externalities, and the economics of time. Empirical analysis: formulating economic questions, finding and analyzing relevant data, and presenting findings to non-specialists.
Prerequisite(s): ECON 2006 or BDS 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3204 - Macroeconomic Theory (3 credits)
Theories of the determination of the level of aggregate economy-wide activity. Employment, the price level, aggregate national income, and the interest rate. The roles of money and expectations.
Prerequisite(s): (ECON 2006 or ECON 2026H) and (ECON 3104 or ECON 2025H) and (MATH 1226 or MATH 1526 or MATH 1026)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3214 - Money and Banking (3 credits)
Money and credit. The U.S. monetary system. Monetary theory, monetary policy and economic stabilization.
Prerequisite(s): (ECON 2005 or ECON 2025H) and ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3254 - Analysis of Economic Data (3 credits)
Sources of economic data. Application of spreadsheet and/or statistical software to analysis of economic relationships using graphical and regression techniques. Emphasis is on economic applications rather than statistical theory.
Prerequisite(s): STAT 3005 or STAT 3604 or STAT 3615 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006 or BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3314 - Middle East Economics (3 credits)
Introduction to the economies of the Middle East and North Africa. Application of economic analysis to economic history and modern economic growth of the region. Historical role of a strong state and Islam in shaping the institutions of private property in Middle Eastern societies. The market for oil and the integration of the region into the global economy. The modern economy of the Middle East with focus on human capital development, inequality, and the role of women.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PHIL 3884, PPE 3884, PSCI 3884

ECON 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3914, PSCI 3914

ECON 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4014 - Environmental Economics (3 credits)
Economic dimensions and aspects of programs designed to impose quality controls upon the environment. Special emphasis on problems of controlling air and water pollution.
Prerequisite(s): ECON 2005 or ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4044 - Public Economics (3 credits)
Economic rationale of the public sector. Proper size and functions of government. Market failure, Cost-benefit analysis, public goods provision. Pricing of public enterprise services.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4054 - Public Finance (3 credits)
The structure and incidence of taxation in the U.S. Effects of taxes on incentives and economic efficiency. Tax Policy.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4074 - Labor Economics (3 credits)
Human capital theory, labor supply and demand, discrimination, effects of labor unions and collective bargaining, wage differentials, income distribution.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 3254 or ECON 4304)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4084 - Industry Structure (3 credits)
The structure and performance of American industry. Dimensions and measures of market structure. Factors affecting market structure. The relationship between structure and performance. Purpose and effects of antitrust policy, regulation, and other public policies toward industry.
Prerequisite(s): ECON 3104 or ECON 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4124 - Growth and Development (3 credits)
Theories of economic growth. Policies to foster growth, and their consequences.
Prerequisite(s): ECON 2006 and (ECON 2025H or ECON 3104)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4135 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4135

ECON 4136 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4144 - Economics of China (3 credits)
Evolution of the Chinese economy since 1949. Exposition of alternative economic systems, the commune, incentive problems, and state owned enterprises. Analysis of recent reforms and their effects on economic efficiency; and key issues of economic transition related to Russia and other East European countries.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4214 - Economics of Health Care (3 credits)
Effects of medical care on health; cost and production of medical care; demand for medical care and its financing; structure of the health care industry; reorganization for efficiency.
Prerequisite(s): ECON 2005 or ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4304 - Introduction to Econometric Methods (3 credits)
An introduction to econometric modeling techniques, including regression methods. Particular emphasis on the special problems posed by economic data.
Prerequisite(s): ECON 3254 or STAT 3005 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006
Corequisite(s): ECON 3104, ECON 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4314 - Big Data Economics (3 credits)
Applied econometrics dealing with big data. Theoretical, computational, and statistical underpinnings of big data analysis. The use of econometric models and deep machine learning algorithms to analyze the high-dimensional data sets. Implications in research focusing on economic questions that arise from rapid changes in data availability and computational technology. Materials are hands-on tutorials that come with Python codes and real-world data sets.
Prerequisite(s): ECON 3254 or ECON 4304 or CMDA 3654 or STAT 3006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4314

ECON 4404 - Economics of Organizations (3 credits)
Economic theories of organization, with specific attention to their internal structure, and to design of incentive systems. Application to mergers, to the relationship between stockholders and managers, etc. Students with one year of economics, calculus and major in some other social science, by permission of the instructor.
Prerequisite(s): ECON 3104 or ECON 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4424 - The Theory of Games and Economic Behavior (3 credits)
Introduction to games and solution concepts, such as prisoners dilemma, noncooperative equilibrium and Nashs bargaining solution. These concepts are applied in analyzing economic problems including bargaining problems, oligopoly and agency.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4434 - Experimental Economics (3 credits)
This is a course in the use of laboratory methods to study behavior in economics and the social sciences. Students will study state-of-the-art methodology in experimental economics, including experimental design, laboratory technique, financial incentives, and analysis of data. Students will participate in, design, and conduct experiments in bargaining, auctions, asset markets, public goods and commons situations, and risky decision-making.
Prerequisite(s): ECON 3104 and (BIT 2406 or MSCI 2406 or STAT 2004 or STAT 3005)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 4454, PSYC 4454

ECON 4514 - Applied Analysis of Banking and Financial Markets (3 credits)
Analysis of economic data with focus on understanding of decision-making in financial markets. Behavior of and optimal outcomes for individuals (consumption, savings, and investment), financial institutions (lending, borrowing, and risk management), regulators, and policy makers. Statistical tools and inference using recent data sets.
Prerequisite(s): ECON 3254 or ECON 4304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4614 - R Programming in Economics (3 credits)
Using R to combine economic theory and data. Focus on general R programming fundamentals related to data science techniques and economic data (gathering, standardizing and cleaning, analysis, and visualization). Hands-on experience with a variety of data, data sources, and techniques within R. Flaws and limitations of data. Direct application with individual project combining economic theory and data using R.
Prerequisite(s): ECON 2005 and (ECON 3254 or ECON 4304)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4754 - Internship (1-3 credits)
Qualified students are placed in an industry or government position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Satisfactory evaluation from employer, detailed reports on the internship experience and a specific project will be required of each intern. Pre: Junior standing, QCA of 2.50 or better and consent.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

ECON 4864 - Developing Behavioral Science Policies and Interventions (3 credits)
Senior-level capstone course to apply theories and models from behavioral decision science to real world problems on topics from education, organizations, health, crime, environment, and volunteerism. Utilize behavioral science theories, data and analytical frameworks from research papers to define and analyze problems or unintended consequences resulting from individual decision-making. Emphasis on identifying specific problems, formulating behavioral policies or interventions to improve performance, and designing experiments and randomized controlled trials to test their effectiveness.
Prerequisite(s): BDS 3134 or ECON 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4864

ECON 4894 - Law and Economics (3 credits)
Analysis of the economic effects of legal rules, with emphasis on the law of property, contract, liability, and land use.
Prerequisite(s): ECON 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ECON 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Education, Counseling (EDCO)

EDCO 2004 - Healthy Relationships: Understanding Self and Others (3 credits)
Basic concepts, skills, and theory associated with creating and sustaining healthy relationships in social and professional settings. Self-awareness as it relates to relationship-building. Characteristics and identities of self and others as they relate to relationship-building. Relationship-building skills such as active listening, perspective taking, and empathy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Education, Curriculum and Instruction (EDCI)

EDCI 1004 - Introduction to Teacher Education and Licensure (1 credit)
Introduction to the School of Education and teacher education program including majors that lead to teacher licensure, education career exploration, curriculum requirements of licensure programs, and state licensure regulations. Review of academic skills, university programs, and services that support students and promote student development.
Instructional Contact Hours: (1 Lec, 1 Crd)

EDCI 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 2004 - Exploring the Teaching Profession- Field Studies in Education (3 credits)
Experiential learning,10 hours per week, in a classroom setting, public or private, exposing students to knowledge, skills, and dispositions of professional educators. Allows for integration of experiential and course-based learning in professional identity formation and classroom management. Introduces students to concepts and terminology necessary for upperlevel educator preparation courses.
Prerequisite(s): EDCI 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2414 - Design Based Biotechnical Learning (3 credits)
STEM disciplinary content and practice. Design, construction, evaluate, and iterate working biotechnical prototype solutions addressing authentic human needs. Ethical decision-making based on technological solutions appropriate for local and/or global communities.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2464 - Foundations of Social Studies Education (3 credits)
Introduction to social studies and the study of the social world in all its complexity including the interactions between people, cultures, societies, systems, and ways of being in the world. Exploration of what social studies encompasses, including its purposes and foundational concepts to provide a content-based foundation for future social studies teachers in history, geography, civics, and economics.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2574 - Social Foundations of Education (3 credits)
History, purpose, and social contexts of education and the PK 12 public education system in the US. Diversity and culturally sensitive approaches to education. Historical, philosophical, social, cultural, and political factors that influence teachers roles and responsibilities and educational practice.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2614 - The Reading Mind: Learning to read (3 credits)
Survey of theories and research that explain how people learn to read. Brief overview of English written systems. Models of skilled reading, literacy stages, and component processes (e.g., decoding, comprehension). Application of course concepts to self, common myths, media, and products. Analysis of patterns of inequity in reading achievement.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2674 - Language, Culture, and Learning (3 credits)
This course explores connections between language, culture, and learning. Emphasis on recognizing and critically examining ways that diversity of cultural contexts and social identities influence learning, and challenging students to consider ethical responsibilities in supporting and participating in an equitable society.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2984 - Special Study (1-19 credits)
Repeatable with different course content.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

EDCI 3004 - Pre-Education Seminar (1-6 credits)
Experiential learning in a PreK through 12th grade setting, public or private, exposing students to knowledge, skills, and dispositions of professional educators. Allows for integration of experiential and course-based learning in professional identity formation and exploration of education careers. NOT student teaching. May be repeated for elective credit up to a maximum of 12 credit hours. Pre: Junior standing.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 12 credit hours

EDCI 3024 - Issues of Schooling in the United States (3 credits)
Exploration of U.S. education, purposes, and roles. Impacts of historic, social, political, economic, religious, cultural, global, and curricular issues. Analysis of equal educational opportunity. Role of the teaching profession in educational reforms.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3074 - Elementary Curriculum: Methods in Teaching (3 credits)
Instructional approaches in elementary education curriculum with a focus on: family engagement, collaboration, teaching strategies, behavior and classroom management, assessment, and differentiation. Design and implementation of lesson plans for elementary school students. Professional educator standards.
Corequisite(s): EDCI 3964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3144 - Education of Exceptional Learners (3 credits)
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 3144

EDCI 3234 - Foundations of Reading Instruction (PK-6) (3 credits)
Theoretical, practical, and research-based foundations in the science of reading instruction for grades PK-6. Phonics, phonological awareness, fluency, vocabulary, and comprehension instruction. Assessment-informed instruction, classroom organization, reader-text matching.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3244 - Curriculum and Instruction in Elementary Mathematics, PK-3 (3 credits)
Key concepts in curriculum and instruction in grades PK-3 mathematics: mathematical thinking, number and number sense, computation and estimation, geometry and measurement, mathematical discourse within elementary classrooms, teaching methods in grades PK-3, and the role of mental arithmetic. Teaching mathematics through problem solving, reasoning, and communication to support the learning process for all elementary students.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3254 - Elementary Methods in Science (3 credits)
Study and analysis of approaches to elementary science instruction; assessment for learning; instructional design and methods; content integration in lesson plans; inquiry based science investigations; planning science investigations; needs of students; and inclusiveness of learners.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3334 - Teaching Language Arts in the Elementary Classroom (4 credits)
Implementation and assessment of curriculum and instruction in elementary language arts. The six focus areas of writing, speaking, listening, reading, visual representation, and viewing are the core components and the role of childrens literature in language learning.
Instructional Contact Hours: (4 Lec, 4 Crd)

EDCI 3354 - STEM in Elementary Schools (3 credits)
STEM education for pre-service elementary education teachers. Equity in elementary science education. Inquiry as a process in society. Integration of inquiry-based practices and engineering design. STEM activities that mirror real-world problem solving and innovation. Next Generation Science and VDOE standards and engineering models, including 5E Instructional Model, in instructional design.
Prerequisite(s): EDCI 3254
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3464 - Elementary Social Studies Teaching Methods (3 credits)
Emphasizes foundational concepts of curriculum in Social Studies for preservice teachers to effectively utilize state and federal standards to guide instructional strategies and assessments in the elementary classroom (PK-6). Functions of Virginia state and local governments. Exploration of alternative approaches with instructional strategies.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3474 - Assessment and Diagnosis in Elementary Mathematics Classroom (3 credits)
Research in assessment and diagnosis in PK-5 mathematics classroom. Comparison of evaluation and assessment methods and development of assessment models appropriate for use in PK-5 mathematics classrooms. This course involves the exploration of formative and summative assessment tools, formal and informal assessment strategies, and critical issues in assessment practices.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 3954G - Study Abroad (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

EDCI 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ART 4014, HIST 4014

EDCI 4024 - Humanizing the K-12 Classroom (3 credits)
Social, political, economic and historic structures maintaining power and privilege in the K-12 education system that disadvantage students of different racial, ethic, socioeconomic, class, and cultural groups. Classroom environmental design to support equity and social justice. Impact of teacher and student identity development on student learning. Twenty hours of experiential learning in educational setting. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4074 - Culturally Responsive Teaching in the Elementary Classroom (3 credits)
In-depth, extensive, and reflective understandings of diversity regarding individual students, families, communities, and schooling contexts. Classroom instructional and management strategies that are responsive to cultural and linguistic differences.
Corequisite(s): EDCI 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4244 - Curriculum and Instruction in Middle School Mathematics (4-8) (3 credits)
Key concepts in curriculum and instruction in grades 4-8 mathematics to meet diverse learning needs. Algebraic structure of the rational numbers as it relates to childrens understanding of fractions, decimals, and percents, algebraic and proportional reasoning, and probability and data analysis. Childrens mathematical thinking and learning from a psychological perspective. Teaching mathematics through problem solving, reasoning, and communication to promote an inclusive community of learning based on appropriate educational theories.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4264 - Intro to Reading Instruction for Elementary Students: A Clinical Course (3 credits)
Overview of reading theory, terminology, and development in grade K-5. Introduction to reading assessment, text selection, lesson planning, and instructional strategies. Supervised clinical setting instructing K-5 learner. Pre: Junior or senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4274 - Curriculum and Instruction in Middle School Mathematics (3 credits)
Key concepts in curriculum and instruction in middle school mathematics to meet diverse learning needs. Algebraic structure of the rational numbers as it relates to understanding of fractions, decimals, and percents, algebraic and proportional reasoning, and probability and data analysis. Mathematical thinking and learning from a psychological perspective. Teaching mathematics through problem solving, reasoning, and communication to promote an inclusive community of learning based on appropriate educational theories.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4454 - Engr. Leadership/Mgmt (3 credits)
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ME 4454

EDCI 4554 - Educating Exceptional Learners (3 credits)
Analysis of purpose, rationale, and foci of educational programs, and related services for individuals with special needs. Identification of characteristics associated with each exceptionality covered by the Individuals with Disabilities Education Act. Review of procedures for assessment, eligibility decisions, and the development of individualized educational programs. Overview of selected instructional strategies, environmental adaptations, and special materials. Examination of findings concerning program efficacy. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4724 - Secondary School Teaching Methods I (3 credits)
Methods for designing and implementing instruction in specific middle and high school content area classrooms (CTE, English, history, social sciences, mathematics, and music) in conjunction with a field experience course. Lesson planning, assessment, differentiation, technology, standards, and adolescent learning development. Reflectivity and collaboration for continuous improvement.
Corequisite(s): 3964, or EDCT 3964, or EDTE 6964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4734 - Adolescent Literacy and Reading (3 credits)
Challenges to adolescent literacy. Basic processes related to reading, comprehension, vocabulary development, and conceptual knowledge; diverse adolescent readers. Effective plans and teaching strategies for comprehending and using information in disciplinary texts in middle and high school content area classrooms. (Career and Technical, English, history, math, music, and science).
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4744 - Secondary School Teaching Methods II (3 credits)
Methods for designing and implementing a variety of instructional approaches in specific middle and high school content area classrooms (CTE, English, history, social sciences, mathematics, and music) in conjunction with student teaching internship. Emphasis on planning and implementation of instructional design, research inquiry, classroom management, integration of technology. Unit plan development and evaluation.
Prerequisite(s): EDCI 4724
Corequisite(s): 3964 or EDTE 3964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4984 - Special Study (1-19 credits)
Repeatable with different content.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

EDCI 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Educational Psychology (EDEP)

EDEP 2374 - Educational Psychology for PK-12 Teachers (3 credits)
Theoretical, empirical, and practical foundations of educational psychology, including human learning, cognitive processes, development, motivation, classroom management, and instructional strategies for diverse students. Emphasis on application of theory to practice.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 2444 - Motivating Yourself and Others (3 credits)
Survey of human motivation research and research methodologies in education, psychology, and neuroscience. Application of this research in diverse populations, including analysis of human motivation and design of motivating activities. (3H,3C)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDEP 3474 - Principles and Practices in PK-12 Assessment (3 credits)
Theoretical, empirical, and practical foundations of assessment in PK-12. Basic test design and measurement principles and practices, the use of assessments in education, the use of assessment data, and critical issues in assessment. Emphasis on creating classroom-level assessment systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Electrical & Computer Engineering (ECE)

ECE 1004 - Introduction to ECE Concepts (3 credits)
Introduction to topics that span the field of electrical and computer engineering (ECE). Content presented through the lens of application with accompanying hands-on exercises. Basics of circuits, op-amps, power supplies, computer logic, system decomposition, and coding. Modeling and application of engineering professionalism. Exploration of ECE in society.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2024 - Circuits and Devices (3 credits)
Analysis and design of passive and active circuits under Direct Current (DC), Alternating Current (AC), and switched excitation. Linear circuit analysis techniques for various circuit topologies. Expressing the transient response of first- and second-order linear circuits using time-domain methods. Calculating the AC steady-state response of linear circuits using phasors and immittances. Characterizing the frequency response of linear circuits. Determining operating point and small signal response of non-linear circuits containing diodes and bipolar transistors. Projects demonstrating circuit design processes adhering to professional practices.
Prerequisite(s): ECE 1004 and (MATH 2114 or MATH 2114H or MATH 2405H)
Corequisite(s): MATH 2214, PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2054 - Applied Electrical Theory (3 credits)
For students in the Mechanical Engineering program or by permission of the ECE Department. Fundamentals of electric circuits; circuit laws and network theorems, operational amplifiers, energy storage elements, response of first and second order systems, AC steady state analysis. Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ECE 2164 - Exploration of the Space Environment (3 credits)
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment; space weather hazards and societal impacts; orbital mechanics and rocket propulsion; spacecraft subsystems; applications of space-based technologies.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 2664

ECE 2214 - Physical Electronics (3 credits)
Fundamentals of electrostatics and magnetostatics, transmission lines, impedance matching networks, electromagnetic (EM) waves, and basic operating principles of diodes and metal-oxide semiconductor field-effect transistors (MOSFETs). Designing MOSFET biasing, and single-ended and differential amplifier circuits. Basic operating principles of complementary metal-oxide semiconductor (CMOS) device and its application as a digital inverter. Electronic circuit design adhering to professional and ethical practices.
Prerequisite(s): ECE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2274 - Electronic Networks Laboratory I (1 credit)
Principles of operation of electrical and electronic test equipment and applications to measurement of circuit parameters. Transient and steady state response of RLC networks. Applications of laws and theories of circuits. Design, prototyping, and testing of electronic devices and circuits. Must have C- or better in prerequisite.
Prerequisite(s): ECE 2074
Corequisite(s): ECE 2204
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 2514 - Computational Engineering (3 credits)
Software development processes for electrical and computer engineering applications. Modeling, simulation, data analysis, and visualization. Computing abstractions and the use of application programming interfaces. Software design and implementation using a procedural, class-based language. Integrated code development and testing. Team-based development of autonomous system applications reinforcing course topics.
Prerequisite(s): ECE 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2544 - Fundamentals of Digital Systems (3 credits)
Design and analysis of digital systems. Information representations and computer arithmetic. Switch and gate design within digital logic. Combinational logic analysis and synthesis, Hardware Description Languages (HDL), and hierarchical design. Finite-state machines, synchronous sequential logic analysis and design. Hardware specification and documentation. Register transfer level architectures, computer organization, memories, and digital interfacing. Instruction set architecture and assembly language programming. Emphasis on the relationship between software and hardware.
Prerequisite(s): ECE 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2564 - Embedded Systems (3 credits)
Use of microcontroller-based embedded systems as a tool to address digital control and sensing in engineering applications. Modern methodologies for programming microcontrollers including programming under real-time and resource design constraints. Finite-state machine modeling and software implementation. Event-driven programming including polling-based and interrupt-driven input/output. Integration of sensors and actuators, use of standard digital and analog interfaces, and use of hardware peripherals in microcontroller architectures. Design of hardware abstraction layers and software architectures for embedded systems. Integration of hardware peripherals into real-time, software applications. Software toolchains for embedded systems, use of debugger and development and testing methodologies. Professional project management and version control.
Prerequisite(s): ECE 2514 and ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2714 - Signals and Systems (3 credits)
Mathematical methods for the analysis and design of continuous and discrete linear, time-invariant systems. Representation of signals using time-domain and frequency-domain methods and the application of Fourier transforms to linear system design and analysis. Descriptions of systems as signal transformations using block diagrams, differential equations, difference equations, convolution, and transfer functions. Applications to signal filtering, measurement, and control of the physical devices. Formal project documentation adhering to professional practices.
Prerequisite(s): ECE 2024 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2804 - Integrated Design Project (2 credits)
Design, implementation, testing, and validation of a hardware and software solution to an open-ended engineering problem integrating both analog and digital components. Using industrial-caliber test and measurement equipment including: oscilloscopes, function generators, power supplies, and digital multi-meters. Technical documentation and oral presentation of design process and solution. Overview of the scope of the electrical and computer engineering profession and issues related to its societal impact and ethical considerations.
Prerequisite(s): ECE 2024 and ECE 2514 and ECE 2544
Corequisite(s): ECE 2214 and (ECE 2564 or ECE 2714)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ECE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 2974 - Independent Study (1-19 credits)
A minimum GPA of 2.0 in all ECE courses is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3004 - AC Circuit Analysis (3 credits)
Application of the basic laws and techniques of circuit analysis to AC circuits. Complex numbers and algebra with an emphasis on phasor representation of circuits. Calculation of the frequency response of circuits with R, L, and C components, independent sources, controlled sources, and operational amplifiers. Analysis of AC steady-state circuits and determination of average power. Magnetically coupled circuits. Laplace and Fourier transforms. Representation of circuits by two-port models. C- or better in prerequisites.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3054 - Electrical Theory (3 credits)
For students in curricula other than ECE or ME. Fundamentals of electric circuits and electronic devices. Fundamentals of electric circuits: circuit laws and network theorems, operational amplifiers, energy storage elements, response of first (Resistive-Inductive RL, and Resistive Capacitive RC) and second order (Resistive-Inductive-Capacitive RLC) systems, Alternating Current (AC) steady state analysis. Basic electronic devices: Diodes and Transistors.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3074 - AC Circuit Analysis Laboratory (1 credit)
Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system. Experiments include: sinusoids and phasors including impedance, admittance, and Kirchhoffs laws; sinusoidal steady- state including node and mesh analysis, Thevenin and Norton equivalent, and op amps; ac power analysis including instantaneous and average power, power factor, and complex power; magnetically coupled circuits including mutual inductance, energy in a coupled circuit, and transformers; frequency response including transfer functions, Bode plots, resonance, and passive and active filters; and two-port circuits. A C- or better is required for all prerequisites.
Prerequisite(s): ECE 2804
Corequisite(s): ECE 3004
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3104 - Introduction to Space Systems and Technologies (3 credits)
Introduction to technologies and computational tools used in space-based applications, including techniques for exploring the planets and the near-Earth geospace environment. Overview of orbits, spacecraft, control of spacecraft, electromechanical system requirements for space-based applications, and space environment interactions with spacecraft systems. Understanding the space environment and the engineering approaches required to operate it. A C- or better is required in prerequisites.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3105 - Electromagnetic Fields (3 credits)
Maxwells equations and their application to engineering problems. ECE 3105: transmission lines, introductory electrostatics, introductory magnetostatics, Faradays Law, properties of uniform plane waves. ECE 3106: electrostatics and magnetostatics, Maxwells Equations, wave propagation in uniform media, the reflection and transmission of plane waves, guided waves, radiation. A C- or better is required in the prerequisites.
Prerequisite(s): ECE 2214 and (MATH 2204 or MATH 2204H or MATH 2406H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3106 - Electromagnetic Fields (3 credits)
Maxwells equations and their application to engineering problems. ECE 3105: transmission lines, introductory electrostatics, introductory magnetostatics, Faradays Law, properties of uniform plane waves. ECE 3106: electrostatics and magnetostatics, Maxwells Equations, wave propagation in uniform media, the reflection and transmission of plane waves, guided waves, radiation. A C- or better is required in the prerequisites.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3134 - Introduction to Optoelectronics (3 credits)
Fundamental principles of optoelectronics. The concept of photons, spontaneous emission, and simulated emission. Rate equation analysis of light emitting diodes and lasers. Operation principles and device characteristics of photodetectors and solar cells. Advanced topics such as quantum well and emerging materials.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3154 - Space Systems - Design and Validation (2 credits)
Introduction to systems and techniques used in electrical engineering design for space-based applications. Students design, fabricate, and test an electronic system following accepted NASA and industry standards, including functional bench-top tests, thermal testing, vibration testing, and long-duration operational testing. Periodic formal reports will document design approaches and test results.
Prerequisite(s): ECE 3105
Corequisite(s): ECE 3104
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ECE 3174 - Optoelectronics Laboratory (1 credit)
Characterization of optoelectronic devices such as light emitting diodes, semiconductor lasers, and photodetectors. Characterization and analysis of optical interference, wave propogation in optical fibers, and optical diffraction. Construction of simple optical imaging systems using lenses and bulk optics.
Prerequisite(s): ECE 2804
Corequisite(s): ECE 3134
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3204 - Analog Electronics (3 credits)
Small signal modeling of transistors. Basic architecture and functionality of linear amplifiers including transistor biasing circuits, current sources, differential amplifier, common emitter amplifier, common source amplifier, emitter follower, source follower, common base amplifier, and common gate amplifier. Frequency response of single stage and multistage amplifiers.
Prerequisite(s): ECE 2214 and ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3214 - Semiconductor Device Fundamentals (3 credits)
Fundamental semiconductor device physics associated with intrinsic and doped semiconductor materials, drift-diffusion of charge carriers, and devices with an in-depth coverage of p-n and Schottky diodes, bipolar junction transistors, and metal-oxide semiconductor and junction field effect transistors.
Prerequisite(s): ECE 2214 or MSE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3254 - Industrial Electronics (3 credits)
Fundamentals of electronics, including basic device principles. Include digital, operational amplifier, and analog analysis for industrial applications and magnetic circuits. For students in the Mechanical Engineering program or by permission of the ECE Department.
Prerequisite(s): ECE 2054
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

ECE 3274 - Electronic Circuits Laboratory II (1 credit)
Design, build, and test amplifiers and other electronic circuits to meet specifications. Bipolar and field-effect transistors, diodes, integrated circuits such as operational amplifiers, and passive components are used. Gain, bandwidth, input and output impedance, positive and negative feedback, and circuit stability are implemented in the designs. Digital oscilloscopes, ammeters, voltmeters, function generators, and power supplies are used. A grade of C- or better is required in all pre-requisite courses.
Prerequisite(s): ECE 3074
Corequisite(s): ECE 3204
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3304 - Introduction to Power Systems (3 credits)
Basic concepts of AC systems, single-phase and three-phase networks, electric power generation, transformers, transmission lines, electric machinery and the use of power. Pre-requisite 3004 with C- or better.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3354 - Electric Power Engineering Laboratory (1 credit)
Laboratory experiments based on principles of electric power engineering.
Corequisite(s): ECE 3304
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3504 - Principles of Computer Architecture (3 credits)
Instruction formats and construction. Addressing modes. Memory hierarchy (cache, main memory and secondary memory) operation and performance. Simple pipelines. Basic performance analysis. Simple Operating System (OS) functions, particularly as they relate to hardware. Virtual memory. Computer Input/Output (I/O) concepts, including interrupt and Direct Memory Access (DMA) mechanisms. Intercomputer communication concepts. Processor design.
Prerequisite(s): ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3514 - Data Structures & Algorithms (3 credits)
Introduction of fundamental data structures, algorithms, and abstract data types. Data structures, arrays, linked lists, stacks, queues, and trees. Algorithms for manipulation, sorting, searching. Tree traversals. Implementation of data structures and algorithms in C++ using good design practices.
Prerequisite(s): ECE 2514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3524 - Introduction to Unix for ECE (2 credits)
Fundamental concepts of operating systems, emphasizing a hands-on introduction to Unix. User interfaces, Unix shell commands, the Unix file system, task management, common system utilities, the Unix programming environment. Students gain experience with system installation and administration.
Prerequisite(s): ECE 2804
Instructional Contact Hours: (2 Lec, 2 Crd)

ECE 3544 - Digital Design I (4 credits)
Design techniques for combinational and sequential logic. Design of digital circuits using standard integrated circuit chips and programmable logic devices. Computer simulation will be used to validate designs. Prototypes will be constructed to demonstrate design functionality.
Prerequisite(s): ECE 2544
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 3564 - Introduction to Computer Networking (3 credits)
Introduction to computer networking featuring the Internet. Internet architecture and layering. Application layer service models and protocols. Transport layer protocols and congestion control. Internet addressing, routing algorithms and protocols. Multiple access and link layer addressing, wireless local area networks (LANs) and cellular networks.
Prerequisite(s): ECE 2544 and ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3574 - Applied Software Design (3 credits)
An introduction to applied software design methods for use in the writing of efficient, reusable, and modular C++ programs. Introduces the use of the following: classes, inheritance, and polymorphism; design patterns; high-level programming techniques using libraries, generics, and containers; widgets, models, and views; software frameworks for embedded systems; and advanced techniques ranging from multi-threading to reflective programming.
Prerequisite(s): ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3604 - Introduction to RF and Microwave Engineering (3 credits)
Introduction to circuits, devices, and systems for radio frequency (RF) and microwave applications. Fundamentals of antennas, propagation, small signal and power amplifiers, frequency conversion, and frequency synthesis. Tools and concepts including s-parameters, design impedance matching, dynamic range, noise figure, and link budget.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3614 - Introduction to Communication Systems (3 credits)
Analysis and design of communication systems with an emphasis on digital communications based on time and frequency domain analysis. Fourier transform techniques, linear systems, and filtering are reviewed. Power and energy spectral density of communication signals. Sampling and quantization of analog signals. Baseband and binary bandpass digital modulation including line coding, pulse shaping, and both pulse and carrier modulation techniques. Wireless communication system concepts including link budgets and multiple access. Transmitter and receiver design concepts. Signal-to-noise ratio, bit error rate, and their relationship. Analog techniques such as Amplitude Modulation (AM) and Frequency Modulation (FM) radio will be reviewed for conceptual and comparative purposes.
Prerequisite(s): ECE 2714 and STAT 4714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3704 - Continuous and Discrete System Theory (3 credits)
Continuous- and discrete-time system theory. Block diagrams, feedback, and stability theory. Continuous-time stability, differential equations, Laplace-transforms, transfer functions. Discrete-time stability, difference equations, Z-transforms. Transfer functions and frequency response. Sampling of continuous systems and an introduction to control and filter design. Hands-on projects to illustrate and integrate the various continuous- and discrete-time concepts and tools.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3714 - Introduction to Control Systems (3 credits)
Introduction to the design of feedback compensation to improve the transient and steady-state performance of systems. Emphasis is on modeling, analysis and analog compensator design for single-input single-output systems. Modeling techniques, root locus analysis and design, the Nyquist criterion, and frequency domain compensation.
Prerequisite(s): ECE 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 4104 - Microwave and RF Engineering (4 credits)
Passive and active Radio Frequency and microwave components and circuits for wireless communications; transmission-line theory; planar transmission-lines and waveguides; S-parameters; resonators; power dividers and couplers; microwave filters; sources, detectors, and active devices; modern RF & microwave CAD; measurement techniques. C- or better in prerequisites.
Prerequisite(s): ECE 3106 and ECE 3204
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4114 - Antennas (3 credits)
Antenna fundamentals, analysis and design principles, and a survey of antenna types including: arrays, wire antennas, broadband antennas, and aperture antennas.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4124 - Radio Wave Propagation (3 credits)
Behavior of radiated electromagnetic waves in terrestrial, atmosphere, space, and urban environments; path, frequency and antenna selection for practical communication systems; propagation prediction.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4134 - Photonics (3 credits)
Fundamental concepts in photonics technology. Basic principles of optical fibers and components such as Bragg gratings, amplifiers, couplers and modulators used in optical communications and sensing. Propagation, dispersion, bandwidth and nonlinear properties of optical signals in optical waveguides and fibers.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4144 - Optical Systems (3 credits)
Fundamental concepts in optical information processing. Ray optics. Optical diffraction. Basic principles and applications of optical imaging using wave optics. Properties of Gaussian Beam. Introduction to Fourier optics, optical spatial filtering, 3D image reconstruction and holography.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4154 - Space Weather: The Solar Wind and Magnetosphere (3 credits)
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earths magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation.
Prerequisite(s): ECE 3105 or AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4654

ECE 4164 - Introduction to Global Positioning System (GPS) Theory and Design (4 credits)
Fundamental theory and applications of radio navigation with the Global Positioning System GPS. Satellite orbit theory, GPS signal structure and theory, point positioning with pseudoranges and carrier phases, selective availability, dilution of precision, differential GPS, atmospheric effects on GPS signals.
Prerequisite(s): ECE 3105 or AOE 4134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: AOE 4464

ECE 4174 - Upper Atmosphere/Ionosphere Space Weather (3 credits)
Interaction of Earth's upper atmosphere and space environment with spacecraft: processes that affect atmospheric density relevant to spacecraft orbit decay; basic composition and structure; radiation and radiative transfer; atmospheric energy balance; atmospheric chemistry and ion production/loss mechanisms; fundamental concepts of Solar-terrestrial physics including ionospheric Chapman theory; atmospheric energy/mass transport; ionospheric electrodynamics; ionospheric storms; planetary atmospheres/ionospheres; instrumentation.
Prerequisite(s): AOE 3014 or ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4674

ECE 4184 - Applied Quantum Mechanics for Engineers (3 credits)
Review of classical mechanics, the simple harmonic oscillator. Schrodinger equation, barrier tunneling, resonant tunneling, and quantum wells. Mathematical foundation of quantum mechanics, Dirac notation and representations, observables, eigenstates and diagonalization. Quantum postulates and its application to two-level systems, harmonic oscillators, creation and annihilation operators. Time evolution of a Hamiltonian. Dynamics of spin and two-level atoms. No cloning theorem and the concept of entanglement.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4194 - Engineering Principles of Remote Sensing (3 credits)
Physical principles involved in remote sensing of Earths environment and their implementation in engineering systems: fundamentals of electromagnetic wave propagation, scattering by matter, effects of propagation media, passive and active systems, remote sensing platforms, data processing, systems integration, and introductory concepts important for the design and analysis of remote sensing engineering systems.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4205 - Electronic Circuit Design (3 credits)
Stability and response of feedback amplifier, wideband amplifiers, operational amplifier characteristics, waveform generators and wave shaping, nonlinear circuit applications, signal generators, and photolithography. Design of analog electronic circuits, circuit simulation, response characterization, and printed circuit construction. C- or better in prerequisites.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4206 - Electronic Circuit Design (3 credits)
Stability and response of feedback amplifier, wideband amplifiers, operational amplifier characteristics, waveform generators and wave shaping, nonlinear circuit applications, signal generators, and photolithography. Design of analog electronic circuits, circuit simulation, response characterization, and printed circuit construction. C- or better in prerequisites.
Prerequisite(s): ECE 4205
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4220 - Analog Integrated Circuit Design (3 credits)
Integrated circuit design in silicon bipolar, MOS (Metal-Oxide-Semiconductor), and BiCMOS (Bipolar Complementary Metal-Oxide-Semiconductor) technologies for communications, sensor, instrumentation, data conversion, and power management applications. Models for active devices in bipolar and MOS technologies; transistor-level amplifiers and output stages (amplifier classifications); transistor-level current mirrors and voltage reference generators, transistor-level operational amplifiers; transistor-level feedback circuits; noise and linearity; layout and simulation of analog integrated circuits with modern VLSI CAD (Very Large Scale Integration- Computer Aided Design) software.
Prerequisite(s): ECE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4224 - Power Electronics (3 credits)
Switching power converter operation and design; modeling of power converters; power components including power semiconductor devices, inductors, and transformers; control of power converters; select power converter topology for applications such as renewable energy, electric transportation, and telecommunications.
Prerequisite(s): ECE 3204 and ECE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4234 - Semiconductor Processing (3 credits)
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 4234

ECE 4244 - Intermediate Semiconductor Processing Laboratory (3 credits)
Design, layout, fabricate, and characterize microelectronic devices. Analyze test results to verify performance to the predetermined specifications. Required oral and written reports. A C- or higher is required in all pre-requisite courses.
Prerequisite(s): ECE 4234 or MSE 4234
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ECE 4254 - Principles of Electronics Packaging (3 credits)
Electrical and thermal design of electronics packaging using finite element analysis software. Materials and process selection guidelines for the fabrication of single- and multi-chip electronics packages. Methods for characterization and testing of electronics packages. Failure mechanisms and design for reliability. Hands-on project experience on electronics packaging.
Prerequisite(s): ECE 2214 or ECE 2054 or ECE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4284 - Power Electronics Laboratory (1 credit)
Design and testing of electronic power processing systems for commercial and aerospace applications.
Corequisite(s): ECE 4224
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4314 - Electric Energy Distribution Systems (3 credits)
Fundamentals of electric power distribution systems. Load characteristics. Modeling of distribution system components (line segments, voltage regulators, and transformers). Distribution flow analysis. Capacitor placement. Symmetrical components and calculation of fault currents. Protection of distribution feeders. Automation/control technologies to enhance reliability, resilience, and security.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4324 - Microgrids (3 credits)
Microgrid: definitions, components, and modes of operation; steady-state analysis and power quality; control modes and hierarchy; renewable resources and their inverter grid-forming and grid-following modes; protection strategies; emerging topics e.g., DC microgrids and datacenters; cybersecurity.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4334 - Power System Analysis and Control (3 credits)
Development of methods for power analysis and control. An analysis and design of systems for steady state, transient, and dynamic conditions. Digital solutions emphasized.
Prerequisite(s): ECE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4354 - Power System Protection (3 credits)
Protection of power apparatus and systems. Fuses. Voltage and current transducers. Relays. Coordination of relays. Pilot channels. Grounding practices. Surge phenomena. Insulation coordination.
Prerequisite(s): ECE 4334
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4364 - Alternate Energy Systems (3 credits)
Electric energy from alternative energy sources including solar, wind, hydro, biomass, geothermal and ocean. Characteristics of direct conversion, electromechanical conversion, and storage devices used in alternative energy systems. Power system issues associated with integration of small scale energy sources into the electricity grid.
Prerequisite(s): STAT 3704 or STAT 4604 or STAT 4705 or STAT 4714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4414 - Linux Kernel Programming (3 credits)
Design and internal organization of the Linux operating system kernel. Kernel subsystems, boot process, memory management, process and thread model, scheduling, interrupt and exception handling, virtual file system and the concrete file system, block I/O and I/O scheduler, network stack, and device drivers. Modification of existing kernel code. Design, implementation, test and evaluation of new kernel modules. Kernel and full software stack debugging techniques, and virtualization as an aid for operating system development and debug. Software engineering techniques to analyze, modify and run a large, complex open-source code base.
Prerequisite(s): ECE 3574 or CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4224

ECE 4424 - Machine Learning (3 credits)
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites.
Prerequisite(s): (ECE 3514 or CS 2114) and (STAT 3704 or STAT 4105 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4824

ECE 4444 - Technological Singularity (3 credits)
True artificial machine intelligence. Societal impact. Historical perspectives. Technological barriers to whole brain emulation. Engineering of superintelligence. Role of consciousness. Cross disciplinary course for students with advanced technical backgrounds, e.g., seniors in engineering, math, physics, biology, or other similar disciplines.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4454 - Multimedia Signal Processing (3 credits)
Signal processing techniques in multimedia systems: concept and principle of multimedia systems; speech analysis and recognition; audio/image/video compression; scene video analysis & understanding; multimedia applications such as human computer interaction, multimedia communication and multimedia security.
Prerequisite(s): ECE 2704 or (ECE 2714 and ECE 2804)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4504 - Computer Organization (3 credits)
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahls Law, Flynns Taxonomy. A grade of C or better required in prerequisites.
Prerequisite(s): ECE 3504 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4504

ECE 4514 - Digital Design II (4 credits)
Advanced digital design techniques for developing complex digital circuits. Emphasis on system-level concepts and high-level design representations while meeting design constraints such as performance, power, and area. Methods presented that are appropriate for use with automated synthesis systems. Commercial hardware description language simulation and synthesis tools used for designing a series of increasingly complex digital systems, and implementing those systems using Field Programmable Gate Arrays (FPGAs).
Prerequisite(s): ECE 3544
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4520 - Digital and Mixed-Signal System Testing and Testable Design (3 credits)
Various topics on testing and testable design for digital and mixed-signal systems are studied: fault modeling, logic and fault simulation, fault modeling, automatic test pattern generation, deterministic ATPG, simulation-based ATPG, delay fault testing, design for testability, built-in-self-test and fault diagnosis.
Prerequisite(s): ECE 2574 and (ECE 3504 or ECE 3544)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4524 - Artificial Intelligence and Engineering Applications (4 credits)
Problem solving methods; problem spaces; search techniques; knowledge representation; programming languages for AI; games; predicate logic; knowledge-based systems; machine learning; planning techniques; reactive systems; artificial neural networks; natural language understanding; computer vision; robotics.
Prerequisite(s): ECE 3514 and STAT 4714
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4525 - Video Game Design and Engineering (3 credits)
4525: Fundamental concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video games. Game design and engineering principles, game architecture, game mechanics and interaction, computer graphics, strategy, artificial intelligence (AI), optimization, play testing and fuzzy logic are included. 4526: Advanced concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video systems. Topics include non-player character (NPC) behavior learning, search and planning, player modeling, procedural content generation, AI-assisted game design.
Prerequisite(s): ECE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4526 - Video Game Design and Engineering (3 credits)
Prerequisite(s): ECE 4525
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4530 - Hardware-Software Codesign (3 credits)
An introduction to the design of mixed hardware- software systems, focusing on common underlying modeling concepts, the design of hardware-software interfaces, and the trade-offs between hardware and software components. Students will use simulation tools to conduct experiments with mixed hardware- software systems in the area of embedded systems.
Prerequisite(s): (ECE 2534 or ECE 2564) and ECE 3544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4534 - Embedded System Design (4 credits)
Team-based major design experience. Design and implement embedded computer systems that incorporate appropriate engineering standards to solve complex problems that include multiple realistic constraints. Writing design documents and making oral presentations as part of the design process. C- or better required in prerequisites.
Prerequisite(s): (ECE 2014 and ECE 2534 and ECE 3574) or (ECE 2564 and ECE 2804 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4540 - VLSI Circuit Design (3 credits)
Introduction to the design and layout of Very Large Scale Integrated Circuits (VLSI). Emphasis is placed on digital CMOS circuits. Static and dynamic properties of MOSFET devices, along with integrated circuit fabrication are examined. Computer-aided design tools are used to produce working integrated circuit designs.
Prerequisite(s): ECE 2214 and ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4550 - Real-Time Systems (3 credits)
Theory, algorithmic and protocol concepts, mechanisms, and implementations of real-time computer systems. Introduction to real-time systems, real-time scheduling, real-time synchronization, real-time operating system kernels, and real-time resource management algorithms (e.g., scheduling, synchronization), their implementations in production operating system kernels, experimental studies of those implementations, and real-time application development.
Prerequisite(s): ECE 3574 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4554 - Introduction to Computer Vision (3 credits)
Techniques for automated analysis of images and videos. Image formation, detecting features in images, segmenting or grouping image regions and image features, multiple view geometry, object instance and category recognition in images and video processing.
Prerequisite(s): ECE 3574 and (STAT 4705 or STAT 4714)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4560 - Computer and Network Security Fundamentals (3 credits)
This course introduces fundamental security principles and real-world applications of Internet and computer security. Topics covered in the course include legal and privacy issues, risk analysis, attack and intrusion detection concepts, system log analysis, intrusion detection and packet filtering techniques, computer security models, computer forensics, and distributed denial-of-service (DDoS) attacks. Must have C- or better in ECE 4564 or CS 3214.
Prerequisite(s): ECE 3564 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4564 - Network Application Design (3 credits)
Application program interface and network transport services including User Datagram Protocol and Transmission Control Protocol from the Internet Protocol suite. Client-server organization and design of synchronous, asynchronous, and multithreaded client and server applications. Design, implementation, and testing techniques to improve robustness and performance. Partially duplicates CS 4254 and credit will not be allowed for both.
Prerequisite(s): ECE 3564 and ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4570 - Wireless Networks and Mobile Systems (3 credits)
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects.
Prerequisite(s): ECE 4564
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4570

ECE 4574 - Large-Scale Software Development for Engineering Systems (3 credits)
Large-scale software implementations of the hierarchy of engineering analysis, design, and decision evaluation. Computer-aided engineering programs with state-of-the-art computer tools and methods. Operator overloading, dynamic polymorphism, graphical user interfaces, generic programming, dynamic link libraries, and multiple threads.
Prerequisite(s): ECE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4580 - Digital Image Processing (3 credits)
This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing focusing on the two major problems concerned with digital images: (1) image analysis and object restoration for easier interpretation of images, and (2) image analysis and object recognition. Some advanced image processing techniques (e.g., wavelet and multiresolution processing) will also be studied in this course. The primary goal of this course is to lay a solid foundation for students to study advanced image analysis topics such as computer vision systems, biomedical image analysis, and multimedia processing & retrieval.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4584 - Robotics Laboratory (1 credit)
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and path planning.
Corequisite(s): ME 4524 or ECE 4704
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ME 4584

ECE 4605 - Radio Engineering (3 credits)
Wireless application circuit design for gain and filter control at radio frequencies to interface the baseband processing systems and the antennas of communication systems. 4605: Design of radio transmitter and receiver circuits using scattering-parameter methods. Circuits include oscillators, radio frequency amplifiers and matching networks, mixers and detectors. 4606: Design of amplitude, frequency, and pulse-modulated communication systems, including modulators, detectors, and the effects of noise. Design basics and guidelines for phase-locked loops and several power amplifier configurations.
Prerequisite(s): ECE 3105 and ECE 3204 and ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4606 - Radio Engineering (3 credits)
Wireless application circuit design for gain and filter control at radio frequencies to interface the baseband processing systems and the antennas of communication systems. 4605: Design of radio transmitter and receiver circuits using scattering-parameter methods. Circuits include oscillators, radio frequency amplifiers and matching networks, mixers and detectors. 4606: Design of amplitude, frequency, and pulse-modulated communication systems, including modulators, detectors, and the effects of noise. Design basics and guidelines for phase-locked loops and several power amplifier configurations.
Prerequisite(s): ECE 4605
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4624 - Digital Signal Processing And Filter Design (3 credits)
Analysis, design, and realization of digital filters. Discrete Fourier Transform algorithms, digital filter design procedures, coefficient quantization. Pre: C or better in 3704
Prerequisite(s): ECE 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4634 - Digital Communications (3 credits)
System and signal level analysis and design for digital communications systems. Review of analog-to-digital conversion and digital baseband communications. Detailed analysis of digital carrier modulation formats including assessment of signal-to-noise ratio, bit error rate, and power and bandwidth efficiency for amplitude-shift keying (ASK), phase-shift keying (PSK), frequency-shift keying (FSK), and Quadrature-Amplitude Modulation (QAM). Matched filter receivers and receiver design, link budgets, and multiple access. Additive-white-noise Gaussian channels. A detailed discussion of random variables will be included to supplement prerequisite material. A C- or better is required in prerequisites.
Prerequisite(s): ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4644 - Satellite Communications (3 credits)
Theory and practice of satellite communications. Orbits and launchers, spacecraft, link budgets, modulation, coding, multiple access techniques, propagation effects, and earth terminals.
Prerequisite(s): ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4664 - Analog and Digital Communications Laboratory (1 credit)
Laboratory experiments which deal with the design and measurement of analog and digital communication systems. Concepts include SNR, Modulation Index, PCM, and spread spectrum.
Prerequisite(s): ECE 3614
Corequisite(s): ECE 4634
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4675 - Radio Engineering Laboratory (1 credit)
Laboratory techniques for radio frequencies including the design of amplifiers, oscillators, and a single-side-band receiver. Associated measurements will be used.
Prerequisite(s): ECE 3106 and ECE 3204
Corequisite(s): ECE 4605
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4684 - Network Science (3 credits)
Introduction to modern-day networked technologies such as wireless, social, and economic networks. Analysis of networked technologies using analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. Introduction to the basics of these techniques and their applications in networked systems. Development of a network science for solving practical problems pertaining to various networked systems such as smartphones, Wiki, Facebook, recommendation systems, economic network, or online video/music streaming software.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Crd)

ECE 4704 - Principles of Robotics Systems (3 credits)
Introduction to the design, analysis, control, and operation of robotic mechanisms. Introduction to the use of homogeneous coordinates for kinematics, dynamics, and camera orientation; sensors and actuators, control, task planning, vision, and intelligence. II
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4805 - Senior Design Project (3 credits)
Industry-like two-semester, team-based major design experience applying knowledge and skills acquired in previous coursework. Design and implement solutions to meet multiple realistic constraints; design to incorporate appropriate engineering standards. A specific, complex engineering design problem is taken from problem definition to product realization and testing. Within the design process, topics include written/oral communication, discourse, ethical reasoning, professional development, project management, and working within a team. 4805: Identify, formulate, and define engineering problem. Generate and select design alternatives. Apply design and analysis methods, from previous courses, to develop, evaluate, and communicate detailed project design. 4806: Implement and refine project design from ECE 4805. Test, analyze, document, and deliver the resulting project outcomes. Pre: 2804 (C-), (12 credit hours of C- or better within their declared disciplinary major) or (9 credit hours of C- or better within their declared disciplinary major and 3 credit hours of C- or better within their secondary focus) for 4805; 4805 (C-) for 4806.
Prerequisite(s): ECE 2214 and ECE 2564 and ECE 2714 and ECE 2804 and (ECE 3004 or ECE 3504) and (ECE 3105 or ECE 3514) and (ECE 3106 or ECE 3134 or ECE 3204 or ECE 3214 or ECE 3304 or ECE 3544 or ECE 3564 or ECE 3574 or ECE 3614 or ECE 3704 or ECE 4205 or ECE 4234 or ECE 4254 or ECE 4424 or ECE 4524 or ECE 4540 or ECE 4580 or ECE 4704)
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4806 - Senior Design Project (3 credits)
Industry-like two-semester, team-based major design experience applying knowledge and skills acquired in previous coursework. Design and implement solutions to meet multiple realistic constraints; design to incorporate appropriate engineering standards. A specific, complex engineering design problem is taken from problem definition to product realization and testing. Within the design process, topics include written/oral communication, discourse, ethical reasoning, professional development, project management, and working within a team. 4805: Identify, formulate, and define engineering problem. Generate and select design alternatives. Apply design and analysis methods, from previous courses, to develop, evaluate, and communicate detailed project design. 4806: Implement and refine project design from ECE 4805. Test, analyze, document, and deliver the resulting project outcomes. Pre: 2804 (C-), (12 credit hours of C- or better within their declared disciplinary major) or (9 credit hours of C- or better within their declared disciplinary major and 3 credit hours of C- or better within their secondary focus) for 4805; 4805 (C-) for 4806.
Prerequisite(s): ECE 4805
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4944 - Cybersecurity Seminar (1 credit)
Theory and practice of cybersecurity problems and solutions for building secure computing hardware, software, and networks. Technical, social and legal aspects of secure systems. Historical and ongoing attacks that spawn real-world responses. Ongoing research in cybersecurity defenses. Senior standing.
Prerequisite(s): ECE 2544 or CS 2505
Instructional Contact Hours: (1 Lec, 1 Crd)

ECE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 4974 - Independent Study (1-19 credits)
A minimum in-major GPA of 2.0 is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 4984 - Special Study (1-19 credits)
A minimum in-major GPA of 2.5 is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ECE 4994 - Undergraduate Research (1-19 credits)
A minimum GPA of 2.0 in all ECE courses is required for enrollment.
Instructional Contact Hours: Variable credit course

Engineering (ENGR)

ENGR 1014 - Engineering Research Seminar (1 credit)
Discussion of current research topics in the College of Engineering by Virginia Tech Faculty. (1C, 1H)
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 1034 - First Year Hypatia Seminar (2 credits)
Success strategies that are designed for first-year female engineering students who are residents of the Hypatia learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineerings departments/majors.
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 1054 - First Year Galileo Seminar (2 credits)
Success strategies that are designed for first-year male engineering students who are residents of the Galileo learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineerings department/majors. (2H, 2C)
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2004A - Engineering International Activity (0 credits)
Engineering International Education course reflects academic effort in study abroad settings as defined by the college. No degree applicable credit awarded. Enrollment in this course does not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2004E - Engineering Experiential Learning (0 credits)
Engineering Experiential course reflects college defined experiential learning experiences for undergraduates. No degree applicable credit is awarded. Enrollment in this course does not apply toward the definition of full time status.
Instructional Contact Hours: (0 Crd)

ENGR 2004R - Engineering Undergraduate Exploratory Activity (0 credits)
Engineering Undergraduate Exploratory Activity course is an undergraduate research experience as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2004S - Engineering Service Learning (0 credits)
Engineering Service Learning course reflects academic effort in service learning settings as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2044 - Second-Year Galileo and Hypatia Seminar (1 credit)
Second-Year Galileo and Hypatia seminar for student leaders. Success strategies designed for second-year engineering students who are participants of the Galileo and Hypatia Living-Learning Community; topics include communication skills, critical thinking skills, diversity, leadership, networking with peers and future employers, and goals associated with academic and professional success.
Prerequisite(s): ENGR 1034 or ENGR 1054
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 2164 - Introduction to Scieneering (1 credit)
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction interdisciplinary thinking and communication; issues related to interdisciplinary research teams.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: COS 2164

ENGR 2464 - Engineering Fundamentals for Scientists (2 credits)
Introduction to the engineering profession and basic engineering skills for students pursuing science majors. Fundamentals of graphing, technical communication, ethics, the design process, project management, and problem solving as applicable to engineering. Partially duplicates ENGE 1024. May not be used for credit towards any degree from the College of Engineering.
Prerequisite(s): ENGR 2164 or COS 2164
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

ENGR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 3044 - Third-Year Galileo and Hypatia Seminar (1 credit)
Success strategies designed for third year engineering students who are participants of the Galileo and Hypatia Living-Learning Community; topics include critical thinking skills, diversity, leadership, networking with peers and future employers, and goals associated with academic and professional success.
Prerequisite(s): ENGR 2044
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 3124 - Introduction to Green Engineering (3 credits)
Introduction to green engineering and global environmental issues. Impacts of human and engineering activities on the environment, and techniques that can be utilized to minimize adverse environmental impacts with emphasis on environmentally conscious design and manufacturing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4064 - Scieneering Capstone (3 credits)
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor.
Prerequisite(s): ENGR 2464 or BIOL 2124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: COS 4064

ENGR 4134 - Environmental Life Cycle Assessment (3 credits)
Quantification of the environmental impacts for products, processes, and systems across all engineering disciplines. A detailed look at life cycle phases and formal and informal Life Cycle Assessment (LCA) methodologies including ISO standards, stream-lined LCA, green building ratings systems, carbon footprints, and other environmental ratings systems.
Prerequisite(s): ENGR 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Engineering Education (ENGE)

ENGE 1004 - Explore Engineering (1 credit)
Students will participate in a seminar-style experience guided by representatives from different engineering disciplines to learn more about the programs offered by the College of Engineering at Virginia Tech to aid the change of major process.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1014 - Engineering Success Seminar (1 credit)
Introduction to opportunities and resources available to College of Engineering students during their undergraduate career at VT. Practice in information gathering skills critical for engineering students. Practice in oral, written, and visual communication. Preparation of an academic plan.
Corequisite(s): ENGE 1215
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1215 - Foundations of Engineering (2 credits)
A first-year sequence to introduce general engineering students to the profession. 1215 (2 credit) data collection and analysis, engineering problem-solving, mathematical modeling, contemporary software tools, professional practices and expectations (e.g. effective communication, working in teams, ethics), and the diversity of fields and majors within engineering. 1216 (2 credits): data collection and analysis, engineering problem-solving, mathematical modeling, design, contemporary software tools, professional practices and expectations (e.g. communication, teamwork, ethics). 1215: Design Lab/Studio (3L, 2C), 1216: Design Lab/Studio (3L, 2C).
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 2 Crd)

ENGE 1216 - Foundations of Engineering (2 credits)
A first-year sequence to introduce general engineering students to the profession. 1215 (2 credit) data collection and analysis, engineering problem-solving, mathematical modeling, contemporary software tools, professional practices and expectations (e.g. effective communication, working in teams, ethics), and the diversity of fields and majors within engineering. 1216 (2 credits): data collection and analysis, engineering problem-solving, mathematical modeling, design, contemporary software tools, professional practices and expectations (e.g. communication, teamwork, ethics). 1215: Design Lab/Studio (3L, 2C), 1216: Design Lab/Studio (3L, 2C).
Prerequisite(s): ENGE 1215
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 2 Crd)

ENGE 1354 - Introduction to Spatial Visualization (1 credit)
Introduction to spatial visualization. Training to improve three-dimensional visualization skills, pictorial sketching, orthographic projection, mental rotation, mental cutting and folding, combining solids.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1414 - Foundations of Engineering Practice (4 credits)
Introduction to engineering profession for transfer General Engineering students including engineering problem solving and design, contemporary software tools, and professional practices and expectations (e.g., communication, teamwork, ethics). Duplicates 1215-1216. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (6 Lab, 4 Crd)

ENGE 1644 - Global STEM Practice: Leadership and Culture (3 credits)
Develop global competencies in science, technology, engineering, and math (STEM) contexts and understand how problems and viable solutions vary across contexts and how intercultural communication and global leadership are important in an interconnected global workforce. Integrates semester-long on-campus module with international module following semester exams (Rising Sophomore Abroad Program). International module engages students in local culture during visits with STEM businesses and universities. Participation in both modules required. Enrollment by application.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ENGE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2094 - Create!: Ideation & Innovation (3 credits)
Apply problem solving framing strategies as part of problem solving design processes. Consider cultural, economic, social, and other perspectives in customer discovery and design processes in order to ensure problem/solution fit. Ideate possible solutions or approaches to address open- ended problems using a variety of methods. Engage in iterative critiques of strategies, solutions and prototypes using methods drawn from industrial design, engineering and the arts. Collaborate in interdisciplinary and diverse project teams. Communicate deliverables in multiple formats and for different audiences. Identify and address impacts of designed services and products through global perspectives, such as patterns of inclusion and exclusion and effects on localized ecosystems.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2524 - Exploring Service Learning Through STEAM/STEM Educational Outreach (3 credits)
Explore volunteerism, traditional service learning, critical service learning, and social change. Develop intercultural competence by examining social identities, power, and privilege with a focus on preK-12 education systems in the United States. Develop Science, Technology, Engineering, Arts, and Math (STEAM) and STEM educational outreach experiences that meet needs identified by community members in teams. Demonstrate career readiness through experiential learning. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2524H - Service Learning Edu. Outreach (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2634 - Introduction to Restricted Research (1 credit)
Introduction to multi-disciplinary, team-based undergraduate engineering research. Emphasis on Department of Defense (DoD) and Intelligence Community missions and projects. Exposure to current restricted research performed around campus. Guest speakers from national labs. Engineering research methods (tools, research integrity/safety/ethics, and communication of results). Deep dive into International Traffic in Arms Regulations-restricted multi-disciplinary DoD engineering problems, potential careers, and security protocols surrounding restricted research and careers.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2984 - Special Study (1-19 credits)
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Instructional Contact Hours: Variable credit course

ENGE 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

ENGE 2984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

ENGE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 3604 - Introductory Industry Design Experience (3 credits)
Workplace and industry culture and practice, including folkways, mores, and ethics, centered on engineering design. Interaction with industry professionals. Workplace competencies including effective teamwork, project management, presenting technical information. Training with software, tools and skills used in design practice in industry.
Prerequisite(s): ENGE 1215 and ENGE 1216
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ENGE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IDS 4094, MGT 4094

ENGE 4104 - Applied Explorations in Innovation (3 credits)
Work in interdisciplinary teams to scope and plan an open-ended design project focused on technology commercialization that addresses a need or problem. Model systems and products computationally and quantitatively to address issues of technical and market feasibility and to predict performance under uncertain conditions. Engage in iterative design process that combines computational and quantitative processes with user-centered design and market analysis. Produce viable design that includes technical specifications, market evaluation, and customer discovery results. Communicate with wide range of audiences. Analyze ethical and intercultural and global impacts of innovation. Pre: 3 credits of foundational quantitative and computational thinking.
Prerequisite(s): STS 2254 and ENGE 2094 and (MGT 4094 or ENGE 4094 or IDS 4094)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 6D Critique & Prac in Design, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 4735 - Interdisciplinary Design Capstone (3 credits)
Team-oriented, open-ended, interdisciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product implementation and validation. 4735: Focus on problem identification, development of customer needs, project management, solution validation and selection, solution design, engineering teamwork, documentation and communication. 4736: Focus on design implementation, design validation, ethical and societal impacts of engineering design, communication and teamwork. Students majoring in Material Science and Engineering, Mechanical Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Biomedical Engineering must meet prerequisite and corequisite requirements for their respective in-major capstone courses.
Prerequisite(s): (ME 3024 and ME 3034 and ME 3304 and ME 3524 and ME 3534 and ME 3624 and ME 4005 and MSE 2034) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 4554) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 3304) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 3204) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4554 and MSE 3304) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4554 and MSE 3204) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 3304 and MSE 3204) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3106) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3106) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3134) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3134) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3204) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3204) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3214) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3214) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3304) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3304) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3544) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3544) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3564) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3564) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3574) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3574) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3614) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3614) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3704) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3704) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4205) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4205) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4234) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4234) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4354) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4354) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4424) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4424) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4524) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4524) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4540) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4540) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4580) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4580) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4704) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4704) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3106) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3106) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3134) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3134) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3204) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3204) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3214) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3214) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3304) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3304) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3544) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3544) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3564) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3564) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3574) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3574) or (ECE 2804 and ECE 3504 and ECE 3105

ENGE 4736 - Interdisciplinary Design Capstone (3 credits)
Team-oriented, open-ended, interdisciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product implementation and validation. 4735: Focus on problem identification, development of customer needs, project management, solution validation and selection, solution design, engineering teamwork, documentation and communication. 4736: Focus on design implementation, design validation, ethical and societal impacts of engineering design, communication and teamwork. Students majoring in Material Science and Engineering, Mechanical Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Biomedical Engineering must meet prerequisite and corequisite requirements for their respective in-major capstone courses.
Prerequisite(s): ENGE 4735
Corequisite(s): (MSE 4055 for MSE majors) or (ISE 4404 for ISE majors).
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Engineering Science and Mechanics (ESM)

ESM 2014 - Professnl Dvlpmnt Seminar ESM (1 credit)
Topics designed to foster the professional development of the ESM student. ESM program objectives and outcomes. Professional careers, employment opportunities, expectations to the profession. Technical concentration within the ESM major. Ethical decision-making, safe and life-long learning.
Instructional Contact Hours: (1 Lec, 1 Crd)

ESM 2104 - Statics (3 credits)
Vector mechanics of forces and moments, free-body diagrams, couples, resultants, equilibrium of particles and rigid bodies in two and three dimensions, forces in trusses, frames, and machines, centroids, centers of mass, distributed forces, internal shear forces and bending moments in beams, shear and moment diagrams, friction, belt friction, area of moments of inertia, parallel axis theorem. Course requirements may be satisfied by taking MATH prerequisite prior to or concurrent with course.
Prerequisite(s): MATH 1226
Corequisite(s): MATH 2204 or MATH 2204H or MATH 2406H
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2114 - Statics & Structures (3 credits)
Vector algebra of forces, movements, couples and resultants. Free-body diagrams. Equilibrium of particles and rigid bodies in two and three dimensions. Friction. Forces in trusses and frames. Centroids, centers of mass, area moments of inertia. Internal axial forces, shear forces, and bending moments in bars in beams. Shear and moment diagrams. Stress and strain in bars in beams.
Corequisite(s): MATH 2204 or MATH 2204H or MATH 2406H.
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2204 - Mechanics of Deformable Bodies (3 credits)
Concepts of stress, strain, and deformation. Factor of safety. Stress-strain relationships and material properties. Stress concentrations. Area moments of inertia. Axially loaded members, torsionally loaded members, bending of beams. Shear and moment diagrams. Stresses due to combined loading. Thin-walled pressure vessels. Transformation of stress including Mohrs circle. Beam deflections and buckling stability.
Prerequisite(s): (ESM 2104 or ESM 2114) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2304 - Dynamics (3 credits)
Vector treatment of the kinematics and kinetics of particles and rigid bodies, Newtons laws, work and energy, impulse and momentum, impact, mass moments of inertia, rotating axes.
Prerequisite(s): (ESM 2104 or ESM 2114) and (MATH 2204 or MATH 2204H or MATH 2406H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 3024 - Introduction to Fluid Mechanics (3 credits)
Fluid properties. Hydrostatics. Derivation and application of the mass, momentum, and energy conservation equations. Dimensional analysis and similitude. Introduction to analyses of pipe flows and piping systems, open channel flows, and fluid forces on solid bodies.
Prerequisite(s): PHYS 2305 and ESM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3034 - Fluid Mechanics Laboratory (1 credit)
Introduction to experimental fluid mechanics. Dimensional analysis. Experiments on fluid properties, flow measurements, and flow visualization, including manometry, determining hydrostatic forces on submerged surfaces, applications of the impulse-momentum principle, velocity measurements, measuring drag forces, quantifying flow in channels. Modern data acquisition techniques.
Prerequisite(s): ESM 2304 and ECE 3054
Corequisite(s): ESM 3234
Instructional Contact Hours: (3 Lab, 1 Crd)

ESM 3054 - Mechanical Behavior of Materials (3 credits)
Mechanical properties and behavior of solid materials subjected to static, cyclic, and sustained loads resulting from stress states, environments, and stress histories typical of service conditions; multiaxial failure criteria; behavior of cracked bodies; fatigue of materials; creep of materials; microstructure-property relationships; design methodologies.
Prerequisite(s): ESM 2204 and (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 3054

ESM 3064 - Mechanical Behavior of Materials Laboratory (1 credit)
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers.
Prerequisite(s): ESM 2204
Corequisite(s): ESM 3054
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: MSE 3064

ESM 3114 - Problem Definition and Scoping in Engineering Design (1 credit)
Define open-ended engineering design projects, identify relevant broad social, global, economic, cultural and technical needs and constraints, determine ways in which technical skills contribute to addressing complex engineering design challenges. Identify a capstone project for ESM 4015-4016. Pre-requisite: Junior standing in ESM.
Prerequisite(s): ESM 2014
Instructional Contact Hours: (2 Lab, 1 Crd)

ESM 3124 - Dynamics II- Analytical and 3-D Motion (3 credits)
Review of Newtons Laws, introduction to Lagranges equations, rotating coordinate systems, particle dynamics, systems of particles, rigid-body dynamics, small amplitude oscillations, holonomic and nonholonomic constraints, phase space and energy methods.
Prerequisite(s): ESM 2304 and (MATH 2214 or MATH 2214H or MATH 2406H) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3134 - Dynamics III - Vibration and Control (3 credits)
Single-degree-of-freedom vibration, n-degree-of-freedom systems, continuous systems, nonlinear systems, system stability, introduction to the feedback control of dynamic systems.
Prerequisite(s): ESM 3124 and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3154 - Solid Mechanics (3 credits)
Introduction to tensors, mathematical description of deformations and internal forces in solids, equations of equilibrium, principle of virtual work, linear elastic material behavior, solution for linear elastic problems including axially and spherically symmetric solutions, stress function solutions to plane stress and strain problems, solutions to 3-D problems, energy methods.
Prerequisite(s): ESM 2204 and (MATH 2214 or MATH 2214H)
Corequisite(s): MATH 4574
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3234 - Fluid Mechanics I-Control Volume Analysis (3 credits)
Fluid statics. Control volume approach to flow analysis: conservation laws, pipe flows, compressible flow, open channel flow.
Prerequisite(s): ESM 2304 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3334 - Fluid Mechanics II-Differential Analysis (3 credits)
Introduction to continuum mechanics for fluid systems. Fluid kinematics. Differential approach to flow analysis: conservation equations, exact solutions, potential flows, viscous flows.
Prerequisite(s): ESM 3234 or ME 3404
Corequisite(s): MATH 4574
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3444 - Mechanics Laboratory (2 credits)
Concepts in instrumentation, data acquisition, and signal analysis. Measurements of mechanics quantities and phenomena associated with solid, fluid, and dynamical systems. Open-ended problem definition and approach formulation. Application and synthesis of engineering mechanics fundamentals to the modeling and solution of open-ended problems. Group-working skills and effective written and oral communication.
Prerequisite(s): ESM 3234 and ESM 3034 and ESM 3054 and ESM 3064 and ESM 3124 and ECE 3054
Corequisite(s): ESM 3134, ESM 3154, ESM 3334
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ESM 3704 - Basic Principles of Structures (3 credits)
Static equilibrium of forces and moments, concurrent and nonconcurrent force systems, center of gravity, concentrated and distributed loads. Solution of trusses. Stress and strain, elastic behavior of materials, cables and arches, shear, bending, and deformation in beams, indeterminate structures. Not available to students in engineering.
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4014 - Applied Fluid Mechanics (3 credits)
Analysis of flow over practical configurations, panel methods, Reynolds-averaged Navier-Stokes equations, turbulent boundary layers, flow separation and three-dimensional effects. Unsteady flows, fluid-structure interactions.
Prerequisite(s): ESM 2074 and ESM 3016
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4015 - Creative Design and Project (3 credits)
Capstone senior design project. Synthesis and application of fundamental principles of engineering science and mechanics to an open-ended problem. 4015: Project proposal, including objectives, goals and plans for project. Identification of needs, constraints, and engineering standards with consideration of public health, safety, and welfare, including ethical, global, cultural, societal, environmental, and economic contexts. Proof-of-concept prototyping. Teamwork and communication of design and project progress. 4016: Design specifications with consideration of public health, safety, and welfare, as well as ethical, global, cultural, social, environmental, and economic factors where applicable. Design, test, and analysis of functional prototype. Teamwork and communication of design and project progress. Pre: Senior standing.
Prerequisite(s): ESM 3114
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4016 - Creative Design and Project (3 credits)
Capstone senior design project. Synthesis and application of fundamental principles of engineering science and mechanics to an open-ended problem. 4015: Project proposal, including objectives, goals and plans for project. Identification of needs, constraints, and engineering standards with consideration of public health, safety, and welfare, including ethical, global, cultural, societal, environmental, and economic contexts. Proof-of-concept prototyping. Teamwork and communication of design and project progress. 4016: Design specifications with consideration of public health, safety, and welfare, as well as ethical, global, cultural, social, environmental, and economic factors where applicable. Design, test, and analysis of functional prototype. Teamwork and communication of design and project progress. Pre: Senior standing.
Prerequisite(s): ESM 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4024 - Advanced Mechanical Behavior of Materials (3 credits)
Mechanical behavior of materials, emphasizing solid mechanics aspects and methods for predicting strength and life of engineering components. Plasticity, failure criteria, fracture mechanics, crack growth, strain-based fatigue, and creep. Microstructure-property relationships, and laboratory demonstrations.
Prerequisite(s): ESM 3054 or MSE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4044 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design.
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4610

ESM 4084 - Engineering Design Optimization (3 credits)
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4084

ESM 4105 - Engineering Analysis of Physiologic Systems (3 credits)
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses.
Prerequisite(s): ESM 2304 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4106 - Engineering Analysis of Physiologic Systems (3 credits)
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses.
Corequisite(s): ME 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4114 - Nonlinear Dynamics and Chaos (3 credits)
Motion of systems governed by differential equations: stability, geometry, phase planes, bifurcations, Poincare sections, point attractors, limit cycles, chaos and strange attractors, Lyapunov exponents. Forced, nonlinear oscillations: jump phenomena, harmonic resonances, Hopf bifurcations, averaging and multiple-scales analysis. Systems governed by discrete maps: return maps, cobweb plots, period-multiplying bifurcations, intermittency, delay coordinates, fractal dimensions.
Prerequisite(s): (ESM 2304 or PHYS 2504) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4514

ESM 4154 - Nondestructive Evaluation of Materials (3 credits)
Concepts and methods of nondestructive evaluation of materials. Discussion of techniques and mathematical bases for methods involving mechanical, optical, thermal, and electromagnetic phenomena; design for inspectability; technique selection criteria; information processing and handling; materials response measurement and modeling; signal analysis.
Prerequisite(s): ESM 3054 and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4194 - Sustainable Energy Solutions for a Global Society (3 credits)
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764.
Prerequisite(s): (CHEM 1035 or CHEM 1055) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4194

ESM 4204 - Musculoskeletal Biomechanics (3 credits)
Skeletal anatomy and mechanics. Muscle anatomy and mechanics. Theory and application of electromyography. Motion and force measuring equipment and techniques. Inverse dynamics modeling of the human body. Current topics in musculoskeletal biomechanics research.
Prerequisite(s): ESM 2304 and (CS 1044 or CS 1064 or CS 1114 or AOE 2074 or ESM 2074 or ME 2004)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4224 - Biodynamics and Control (3 credits)
Study of human movement dynamics and neuromuscular control of multi-degree-of-freedom systems. Computational simulation of forward-dynamics and state-space linear control of human movement to investigate functional performance and neuromuscular pathology.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4234 - Mechanics of Biological Systems (3 credits)
Anatomy and physiology of biological systems such as cells, tissues, and organs. Experimental techniques for determining the mechanical behavior of biological systems. Simplified mechanics-based mathematical models of biological systems. Specific biological systems include cells, tissues, and organs of the musculoskeletal, cardiovascular, integumentary system, and reproductive systems.
Prerequisite(s): ESM 2204 and MATH 2214 and MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4234

ESM 4245 - Mechanics of Animal Locomotion (3 credits)
4245: Mechanical and biological principles of terrestrial animal locomotion, including walking, running, jumping, climbing, burrowing, and crawling. Terrestrial locomotion- based bio-inspired design. 4246: Mechanical and biological principles of animal locomotion in fluids, including active and gliding flight, swimming, jetting, and running on water. Engineering design inspired by fluid based biological locomotion.
Prerequisite(s): ESM 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4246 - Mechanics of Animal Locomotion (3 credits)
Mechanical and biological principles of of animal locomotion in fluids, including active and gliding flight, swimming, jetting, and running on water. Enginneering desgn inspired by fluid-based biological locomotion.
Corequisite(s): ESM 3024 or ESM 3234 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4304 - Hemodynamics (3 credits)
Study of the human cardiovascular system and blood flow. Anatomy and physiology of the human heart, vascular system, and its organization. Blood physiology and rheology. Non-Newtonian blood flow models. Steady and pulsatile blood flow in rigid and elastic arteries. Pressure waves in elastic arteries. Three-dimensional blood flow in the aortic arch and flow around heart valves.
Prerequisite(s): ESM 3334 or ME 3404 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4404 - Fundamentals of Professional Engineering (2 credits)
A refresher of basic principles and problem solving techniques involving twelve subject areas most common to all engineering curricula. The topics include those tested by the National Council of Engineering Examiners on the EIT (Engineer in Training) examination, the first requirement, in all fifty states, toward P.E. (Professional Engineer) licensing. Duplicates material of other engineering courses and impracticable for non-engineers, hence not usable for credit toward any degree. Pre: Junior and senior standing in Engineering or in Building Construction or Graduate students in Engineering.
Instructional Contact Hours: (2 Lec, 2 Crd)

ESM 4444 - Stability of Structures (3 credits)
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion.
Prerequisite(s): AOE 3024 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4054

ESM 4614 - Probability-Based Modeling, Analysis, and Assessment (3 credits)
Uncertainty analysis of engineering data, parameters estimation, probability concepts, random variables, functions of random variables, probability-based performance functions and failure modes, risk and reliability functions, probability of failure and safety index, random sequences and stochastic processes, correlation functions and spectral densities, return period and extreme values, failure rates, performance monitoring and service life prediction.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4614

ESM 4734 - An Introduction to the Finite Element Method (3 credits)
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied.
Prerequisite(s): (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) and (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4024

ESM 4904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

English (ENGL)

ENGL 1EWL - Waiting List for English 1105 (0 credits)
Instructional Contact Hours: (0 Lec, 0 Crd)

ENGL 1004 - Books, Libraries, Archives (3 credits)
First-Year Experience course that introduces students to primary objects and methods of inquiry and invention in English studies. Introduction to library and archival research, ethical inquiry, social and historical function of reading, role of books in society, technologies of publication and reading, and writing effective summaries and critical reflections.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1105 - First-Year Writing (3 credits)
1105: Introduction to rhetorical analysis, visual rhetoric, critical writing, and critical thinking; intensive reading of works in multiple genres; practice in writing and revision; fundamentals of oral presentations. 1106: Continued study in rhetorical analysis and the conventions of various genres; intensive instruction in writing and revision of work that incorporates research; experience in oral presentations.
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1106 - First-Year Writing (3 credits)
1105: Introduction to rhetorical analysis, visual rhetoric, critical writing, and critical thinking; intensive reading of works in multiple genres; practice in writing and revision; fundamentals of oral presentations. 1106: Continued study in rhetorical analysis and the conventions of various genres; intensive instruction in writing and revision of work that incorporates research; experience in oral presentations.
Prerequisite(s): ENGL 1105
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1504 - Introduction to Contemporary Linguistics (3 credits)
Introduction to the sounds of language, processes by which words and sentences are formed, how the meanings of words are established by context, and why languages vary and change over time.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1514 - Language and Society (3 credits)
English language variation considered from social, regional, ethnic, gender, and style perspectives. Emphasis on vernacular varieties of American English. Attention paid to the social evolution of different language varieties and sociolinguistic perceptions of language ideologies. Introduction of methods of data analytics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1524 - Language and the Mind (3 credits)
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 1524

ENGL 1604 - Introduction to Poetry (3 credits)
Examination of poetry across historical periods, cultural contexts, and geographical areas. Emphasis on poetic forms and conventions, elements of poetic technique, poetic genres, and the vocabulary of poetic craft.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1614 - Introduction to Short Fiction (3 credits)
Analysis of short fiction and novellas from different historical periods and cultures. Emphasis on the structural elements of fiction, on its flexibility as a form for exploring human desires, conflicts, and values, and on its employment by writers from different cultures, ethnicities, and genders.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1624 - Introduction to Detective Fiction (3 credits)
Analysis of classic and modern texts of detective fiction selected from a variety of historical periods and cultural traditions. Emphasis on the structural elements of detective fiction, on its various sub-genres, and on its employment by writers from different cultures, ethnicities, and genders.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1634 - Introduction to Shakespeare (3 credits)
Introduction to Shakespeares drama and poetry, including at least one modern adaptation of a Shakespearean play (play, novel, movie, opera, etc.). Emphasis on the structural elements and conventions of the different genres of Shakespearean plays and poetry and on their representations of gender and ethnicity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1644 - Introduction to World Literature (3 credits)
World literature in translation. Texts from different time periods, nations, and cultures. Emphasis on close reading, literary elements and conventions, recurring themes, historical and cultural contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1654 - Introduction to Science Fiction and Fantasy (3 credits)
Introduction of literary works within the genres of science fiction and fantasy, focusing on the development and principal characteristics of each genre. Emphasis on the social, cultural, and historical contexts in which particular speculative texts have been produced.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1664 - Introduction to Womens Literature (3 credits)
Introduction to literature written by women, primarily in English. Focus on literary and cultural questions raised in womens writing throughout history and from different social and cultural backgrounds.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1704 - The Harry Potter Phenomenon (3 credits)
Introduction to a millennial childrens literature phenomenon, J.K. Rowlings seven-volume Harry Potter series, and to various critical and cultural responses to the books. Subgenres of fiction used in the series, such as the boarding-school novel and the sports novel; recurring themes in the series; critical concepts such as the Byronic hero and the anti-hero; the role of media in making the series an economic phenomenon; and the relationships of the novels to film versions and fan-fiction spin-offs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1714 - True Crime Stories in American Culture (3 credits)
Analysis of true crime stories across various media and genres. Emphasis on the origins of true crime, narrative features and conventions of true crime stories, and the social, political, and ethical issues raised by their production and consumption, particularly in terms of race, gender, class, and other components of identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2014 - Food Writing (3 credits)
Introduction to the study, analysis, and production of food writing and food media; applied, iterative writing practices within multiple genres focused on the cultural and humanistic qualities of food.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2034 - Analyzing the Sounds of Language (3 credits)
Examination of the acoustic attributes of vowels and consonants using quantitative techniques. Statistical analysis of acoustical differences between and within speakers, enabling predictions about future language choices and outcomes. Basic introduction to using computational software for data processing and visualization, and to ethical issues that arise in collecting an analyzing data.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2044 - Contemporary African American Theatre (3 credits)
Contributions of U.S. Black theatre artists; intersectional identities; performances spaces and society; critical race theory; dramatic storytelling; cultural behaviors; racial discrimination.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2044, TA 2044

ENGL 2104 - African American Linguistics (3 credits)
Overview of some of the language varieties used by African Americans, including African American English, Black American Sign Language, Gullah, Louisiana Creole, and Afro-Latino varieties of Spanish and English. Focus on historical, contemporary, sociopolitical and linguistic factors impacting language practices at the individual and community level. Examination of African American language styles used in expressive forms of art and politics, but also how language ideologies shape responses to African American language in educational, political, and judicial settings. Uses lens of African American Language to explore key linguistic concepts like phonology, morphosyntax, prosody, language acquisition, language contact, and language change.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2104

ENGL 2434 - Legends of King Arthur (3 credits)
Introduction to legends of King Arthur, including stories, novels, and films from a wide historical timespan. Tales of knights, kings, and fair maidens that have entertained generations and irrevocably shaped cultural values surrounding gender relations, justice, violence, and the use and abuse of power. Analysis of individual texts and broader consideration of the Arthurian tradition during key literary-historical periods from the medieval era to the present.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2434

ENGL 2444 - Ancient Greek and Roman Mythology (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2444, RLCL 2444

ENGL 2534 - American Literary History (3 credits)
Introduction to American literary traditions, from the Colonial period through Modernism. Emphases on historical, social, and cultural contexts as these are reflected by representative texts.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2544 - British Literary History (3 credits)
Introduction to British literary traditions, from the Anglo-Saxon period through Modernism. Emphasis on historical, social, and cultural contexts as these are reflected by representative texts.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2604 - Introduction to Critical Reading (3 credits)
A writing intensive introduction to the techniques and theoretical implications of close reading and to the literary genres of poetry, drama, fiction, and, in some sections, non-fiction. The focus is on four primary texts, at least one of which was written before the eighteenth century and one after it, and on criticism of at least one of these. The course emphasizes the analytical skills, basic critical terminology, and conventions of literary criticism essential to advanced English studies. Intended primarily for English majors and minors.
Prerequisite(s): ENGL 1105 or COMM 1015
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2634 - Writing and Social Justice (3 credits)
Study of writings about social justice in various local and global contexts. Critical and rhetorical analysis of discourses in social justice through intersectional approaches.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2644 - Introduction to African-American Literature (3 credits)
An introduction to the principal themes, genres, and historical contexts of African-American literature. Formal elements of both the vernacular and written traditions. Impact of historical and social contexts. Ethical questions raised in the literature.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2644

ENGL 2664 - Being Human: Literature and Human Experience (3 credits)
Depictions of nature, the inhuman, and the superhuman in literature; literary explorations of empathy, technology, race, gender, language, dis/ability, and labor in human experience. Novels, short stories, and poems that explore issues of the human: how to define what is human (recognizing flexible and perhaps permeable boundaries between human and nonhuman), how to defend the human (humans at war with themselves and others), how humans are exploited (labor and human capital), and how humans change (technological development and future human evolution). Imaginative and ethical issues in different genres. Revolving topics course; may be repeated once for credit.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2724, LAHS 2724, STS 2724

ENGL 2744 - Introduction to Creative Writing (3 credits)
A workshop for beginning writers who will identify and apply formal elements of a variety of genres and employ the skills, tools, methods, and iterative processes used by creative writers to produce fully developed works of art.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2804 - Contemporary Native American Literatures (3 credits)
This course offers a sampling of fiction, poetry, and non-fiction by the most influential American Indian writers since 1970, authors such as Momaday, Silko, Deloria, Welch, Harjo, and Alexie. Students also learn about those aspects of cosmology and storytelling traditionally shared by all American Indian Nations, as well as about those aspects specific to the individual tribal traditions from which the authors and their characters come.
Prerequisite(s): ENGL 1106 or ENGL H1204 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2804

ENGL 2814 - Writing for Podcasts (3 credits)
Analysis of exemplary and diverse podcasts, in both audio and transcribed formats. Application of creative writing and technical skills necessary for the composition of original and diverse audio programs. Implementation of formal podcast elements, such as development, performance, structure, production, and promotion. Exploration of creative projects involving scriptwriting, serialized storytelling, hybridized genres, vocal performance, extemporization.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2844 - Introduction to Professional and Technical Writing (3 credits)
Foundations of professional and technical writing and its functions in workplace settings. Practice with problem solving and decision making, audience analysis, document design, usability, and inclusive and ethical documentation, individually and in teams. Practice writing workplace genres such as proposals, reports, and correspondence. Analyze how writing elements such as design, language choices, and diverse data sources affect a document's usability for different audiences.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 3024 - Religion and Literature (3 credits)
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of religion and literature. Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3024

ENGL 3134 - Gender and Linguistics (3 credits)
Exploration of differences--real and imagined--in the speech of men and women, and the relationship between these differences to culture. Exploration of how language can reflect and reinforce gender inequality. Linguistic phenomena covered: pitch, vocabulary, sound change, language ideologies, and discourse strategies and types.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 3134

ENGL 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3144, SOC 3144

ENGL 3154 - Literature, Medicine, and Culture (3 credits)
The representation of health and illness in literature and the cultural aspects of medicine as a practice.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3204 - Medieval Literature (3 credits)
This course presents medieval British literature from ca. 700 to 1500 in its representative modes and defining contexts, including the literary influences of pagan antiquity, the native British (Celtic) tradition, Scandinavian and contemporary continental influences, the Crusades, the Byzantine Empire, and the philosophical traditions of neoplatonism and scholasticism. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3214 - Renaissance Literature (3 credits)
This course presents Renaissance British literature from 1500-1660 in its representative modes and defining contexts, including the discovery of the Copernican universe and the new world, the rise of Protestantism, the resultant Counter-reformation, the movement from humanism to empiricism, and the institution of Parliamentary democracy. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3234 - Romantic Literature (3 credits)
This course presents Romantic literature from the late eighteenth century to 1832 in its representative modes and defining contexts, including the French, American, and Industrial Revolutions, the expansion of the British empire, the rise of the novel, Gothicism, and the intellectual influence of periodical essays. Specific authors and texts will vary, but will include poetry, fictional prose, and non-fictional prose.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3264 - Modernist British Literature (3 credits)
This course presents Modernist British literature from 1918-1945 in its representative modes and defining contexts, including World Wars I and II, the collapse of the British empire, the influence of Darwin, Marx, and Freud, and such literary movements as Modernism, Realism, and Stream of Consciousness. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3304 - The Languages of Native America (3 credits)
Study of the structures of the native languages of the Americas; their interrelationships; their use in individual speech communities; contact with other languages; the interrelationships of linguistic structure, culture, and thought; their future survival.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3304

ENGL 3315 - Playwriting (3 credits)
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required for 3316.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: TA 3315

ENGL 3324 - Acts of Interpretation (3 credits)
Foundational interpretive approaches in literary and rhetorical studies. Emphasis on broad frameworks and their implications for textual analysis.
Prerequisite(s): ENGL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3364 - Topics in Literature by Women (3 credits)
This rotating topics course examines literature written by women with different national and ethnic identities and from different historical periods. Specific content varies, but the common focus is on the fundamental issues surrounding womens writing, the critical methodologies commonly employed to analyze this writing, and the historical, social, and literary contexts influencing the particular writing being studied. May be repeated once with different content.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3424 - Topics in Russian Literature in English (3 credits)
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: RUS 3424

ENGL 3434 - The Works of Vladimir Nabokov (3 credits)
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RUS 3434

ENGL 3474 - Rhetoric for Professional Writers (3 credits)
Rhetorical theory and writing in professional, technical, and public contexts. Culture, access, power, and ethics in relation to rhetoric in professional and technical writing. Rhetoric strategies for textual and digital production.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3514 - Ethnic Literature for Children (3 credits)
This course examines the historical contexts of and issues surrounding ethnic literature for children. The course considers the literature in terms of aesthetics, cultural representations, and identity. Ethnic literatures considered may include Native American, African American, Asian American, and Latino/a. The course also introduces other ethnic literary traditions, such as world folk tales, that influence or parallel American ethnic childrens books.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3524 - Literature for Children (3 credits)
General critical and historical survey of traditional and contemporary writing for children: picture books, folk literature, modern fantasy, poetry, drama, modern fiction, historical fiction.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3534 - Literature and the Environment (3 credits)
Study of fiction, poetry, and non-fiction that examine environmental issues, sustainability, and the relationship between the human and natural worlds within a local and global context.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3544 - Literature and Cinema (3 credits)
Works of literature and the films into which they have been transformed; emphasis on differences between media.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CINE 3544

ENGL 3624 - Appalachian Literature (3 credits)
Appalachian literature from the region's beginnings to the present, including such diverse voices as women, Native American, Affrilachian, LGBTQ, and Latinx populations. Literary perspectives on the relationships between self, family, and community; place and displacement; and humans and the natural world. Analysis of stereotypes that have perpetuated inequity and displacement of power, as well as consideration of regional efforts to reclaim equity, power, place, and identity.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3624

ENGL 3644 - The Postcolonial Novel (3 credits)
A study of novels examining the historical, social, and cultural contexts before, during, and after colonization. Emphasis on major writers (e.g., Achebe, Coetzee, Roy, Phillips) across continents (Africa, Asia, North America) and the significant themes, tropes, and theories of the genre.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3654 - Ethnic American Literature (3 credits)
Variable content course which introduces major American ethnic literatures: African-American, Asian-American, Chicano/a, Arab-American, and Native American. Representative texts from one or two of these categories are examined within the cultural, historical, and geographical matrices within which they are written. May be repeated twice for credit if the content is different.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 3684 - Literature and the Law (3 credits)
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3684H - Literature and the Law (3 credits)
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3694 - Topics in World Novels (3 credits)
Rotating-topics course in world novels, either translated into, or originally written in, English. Emphasis on critical reading of novels written from different historic, intellectual, and cultural contexts. Formal and aesthetic analysis to identify themes, traditions, and values that cross periods and national boundaries. May be repeated once with different topics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 3704 - Creative Writing: Fiction (3 credits)
This course is designed for students who want to focus in some depth on the writing of various forms of fiction such as the short story and novella. Emphasis is on the writing the critiquing of original fiction in a workshop/studio environment, and the analysis of exemplary texts which serve as models. Students produce a body of original fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3714 - Creative Writing: Poetry (3 credits)
This course is designed for students who want to focus in some depth on the writing of poetry. Emphasis is on the writing and critiquing of original poetry in a workshop/studio environment, and the analysis of exemplary poems which serve as models. Students analyze various poetic forms and produce a revised body of original poetry. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3724 - Creative Writing: Creative Non-fiction (3 credits)
This course is designed for students who want to focus in some depth on the writing of creative non-fiction in its various forms, including memoir, personal experience writing, the lyrical essay, travel narratives, and nature writing. Emphasis is on the writing and critiquing of original creative non-fiction in a workshop/studio, environment and the analysis of exemplary texts which serve as models. Students produce a body of original non-fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3734 - Community Writing (3 credits)
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative writing pedagogy and in creating sustainable community partnerships.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3734H - Community Writing (3 credits)
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative writing pedagogy and in creating sustainable community partnerships.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3744 - Writing Center Theory and Practice (3 credits)
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professors consent.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3744H - Writing Center Theory and Practice (3 credits)
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professors contest.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3754 - Advanced Writing and Research (3 credits)
Advanced study in critical reading and writing for diverse academic, professional, civic, and/or personal contexts, culminating in a course portfolio; applied practice with audience-specific texts in multiple genres, modes, and styles; advanced instruction in research strategies and writing processes for complex rhetorical environments; emphasis on the influence of social and cultural identities across writing contexts.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3764 - Technical Writing (3 credits)
Principles and processes of effective written communication of technical information. Strategies for analyzing various workplace communication situations, adapting to audiences, evaluating online content, understanding ethical dimensions of research, and composing technical discourse, including organizing visual and verbal information. Practice in writing, individually and collaboratively, instructions and procedures, proposals and reports, correspondence, and presentations. Junior standing.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3774 - Business Writing (3 credits)
Principles and processes of effective communication required to succeed in business in global and intercultural contexts. Strategies for writing effective messages, analyzing workplace communication situations, adapting information to various audiences, conducting ethical research, giving oral presentations. Practice in writing memos, letters, emails, blog posts, proposals, and reports. Junior standing required.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3784 - Screenwriting (3 credits)
A workshop course in the craft and art of screenwriting, acquainting students with the standard format of screenplays and evaluation of dramatic structures of influential screenplays. Emphasis on construction of dramatic situations, employing the use of action in developing character and theme. Employment of scene as a visual unit of composition, and the evaluation of dramatic structures of influential screenplays.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3804 - Technical Editing and Style (3 credits)
Technical Editing and Style explores the art of editing from the initial writing task to the final delivery of the document. In addition to learning document management, students study and practice the roles, responsibilities, and tasks that editors perform. The course also covers the rules that govern the fundamentals of style (correctness, clarity, and propriety) and the principles needed to match the tone and formality to the aim, audience, and occasion of the work. Must have pre-requisites or the consent of the Director of Professional Writing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3814 - Creating User Documentation (3 credits)
This course prepares students to produce both print and online user documentation that enables people to accomplish a given set of tasks (e.g., user guides, online help, policy and procedure manuals, tutorials, and how-to books). Readings include rhetorical theory and discussions of professional practice. Students learn the principles of user and task analysis, information design, usability testing, and indexing. In addition, they have opportunities for hands-on experience with clients and end-users. Must have pre-requisites or the consent of the Director of Professional Writing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3824 - Visual Rhetoric and Document Design (3 credits)
Theory and practice of visual rhetoric and document design, including attention to ethical design standards and the sociocultural implications of design. Analysis of rhetorical situations to determine the needs of diverse audiences and make effective and ethical design choices. Application of rhetorical theories and formal design strategies to the production of print and digital artifacts using industry-standard design tools (i.e., Adobe InDesign, Illustrator, and Photoshop). Development of the ability to analyze and critique the work of others and to apply such assessments to improve designs in terms of aesthetics and usability.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3834 - Intercultural Issues in Professional Writing (3 credits)
Intercultural and global dimensions of professional and technical writing, including theoretical perspectives and practical applications. Theories of culture, context, identity, language, and technology as relevant to technical and professional communication. Issues of social equity and justice in the field of professional and technical writing. Approaches to engaging in intercultural communication in practice, including localization, globalization, translation, and designing information for and with communities.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3844 - Writing and Digital Media (3 credits)
Fundamental exercises in the production of digital media for internet-capable devices, such as data visualizations, videos, web design, and more. Introduction to ethical reasoning, and its application to contemporary issues about digital media and writing within the context of broader business, organizational, and political practices to collect and use user data.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ENGL 3954 - Study Abroad (1-9 credits)
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

ENGL 3954B - Study Abroad (1-6 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ENGL 3954M - Study Abroad (1-9 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)

ENGL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4004 - Linguistic Discourse Analysis (3 credits)
Introduction to discourse analysis. This course examines spoken and written discourses of English. Further attention will be paid to how discourse functions in political, legal, medical, and educational contexts.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4054 - History of the English Language (3 credits)
Development of English including both its internal history (sounds, vocabulary, inflections, syntax) and its external history (political, social, and intellectual forces). Indo-European origins through the present, with special emphasis on the English Language in America.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4074 - Syntax (3 credits)
Examination of the systemic organization of sentence patterns in human languages. Formulation of problems and evaluation of competing syntatic analyses at the phrase and sentence levels. Analysis of the architecture of phases and of movement processes for grammatical and pragmatic informational coding.
Prerequisite(s): ENGL 1504
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4084 - Conducting Research in the Language Sciences (3 credits)
Research methodology for the study of linguistic structure, sociolinguistic variation, and cross-field approaches. Ethical research methods, data collection, data processing and analysis, presentation of research.
Prerequisite(s): ENGL 1504 and (ENGL 3134 or WGS 3134 or ENGL 3144 or RLCL 3144 or SOC 3144)
Corequisite(s): ENGL 4074, ENGL 4144
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4114 - Chaucer (3 credits)
Critical analysis of themes, styles, and structures in works of Geoffrey Chaucer. Ethical issues, historical context, and cultural traditions. Structure and vocabulary of Middle English. Influence in literary and critical traditions historically and today.
Prerequisite(s): (ENGL 1106 or ENGL 1204H) or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4124 - Introduction to Old English (3 credits)
Introduction to Old English grammar and reading of Old English poetry and prose. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4134 - Language Development (3 credits)
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono-and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 4134

ENGL 4144 - Phonology (3 credits)
Examination of the systematic organization of sounds in human languages based upon problem-based learning. Analysis of syllables and morae, articulatory features, timing of articulatory gestures, and phonological processes that lead to sound change. Assessment of various theoretical and computational approaches to phonology including Articulatory Phonology, Prosodic Phonology, and Optimality Theory.
Prerequisite(s): ENGL 1504
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4164 - Studies in Shakespeare (3 credits)
Revolving topics in Shakespeares drama and poetry, with emphases on poetic and dramatic genres, historical and cultural contexts, significant themes, and popular reception. Additional attention paid to the critical discourse surrounding Shakespeares work. May be repeated twice with different content for a maximum of nine credit hours.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4204 - Hybrid Forms (3 credits)
Advanced writing workshop. Focus on the fusion of genres, such as prose poetry and multimedia writing, with special emphasis on anomalous and/or experimental forms, like cronicas/chronicles, manifesto/artist's statement, microfiction, erasure, collage, third person nonfiction, flash nonfiction, and the lyric essay. Skills, tools, methods, and iterative processes essential to the production of works of literary art.
Prerequisite(s): ENGL 3704 or ENGL 3714 or ENGL 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4214 - Milton (3 credits)
Miltons poetry from the early works, including COMUS, LYCIDAS, and the sonnets, to his major late works PARADISE LOST, PARADISE REGAINED, and SAMSON AGONISTES; with some attention to the important prose and to the historical context in which he wrote.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4314 - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4314

ENGL 4314H - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 3154 or ENGL 3324
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4314

ENGL 4434 - The American Novel (3 credits)
Development of the American novel from its beginnings in the late 18th century to 20th century postmodernism. Emphasis on works representative of major authors (e.g., Twain and Morrison), important types (e.g., the romantic novel, the historical novel), and significant American themes (e.g., religion, nature, slavery, the frontier).
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4444 - The British Novel (3 credits)
Development of the British Novel from the mid- eighteenth century to World War II, including works by such novelists as Defoe and Austen (origins through romantic era), Dickens, Hardy, and Stevenson (Victorian and Edwardian era), Joyce, Woolf, and Waugh (modern period). Emphasis on evolution of generic styles and conventions against a changing landscape of historical and cultural change.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4474 - Special Topics in Professional and Technical Writing (3 credits)
Advanced, variable-content course that explores a significant or emergent professional & technical writing issue. Examines relevant theories and historical contexts to analyze relationships among rhetoric, culture, access, and power. Identifies common themes and approaches and applies these themes and approaches, shaped by current theories, to professional and technical writing projects. Individual sections focus on differing areas of professional and technical writing (to be specified in the subtitle of the course). May be repeated twice with different content for a maximum of nine credit hours. Pre: Junior Standing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4504 - Modern Poetry (3 credits)
British and American poetry from 1900 to World War II with emphasis on such figures as Pound, Williams, Stevens, Yeats, Plath, Smith, and Eliot.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4514 - Contemporary Poetry (3 credits)
British and American poetry from World War II to the present, with emphasis on such figures as Bishop, Lowell, Ashbery, Heaney, and Hughes.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4624 - Studies in a British Author after 1800 (3 credits)
This course examines the life, work, and critical reception of a single major British author (or pair of closely associated authors) writing after 1800. May be taken up to 3 times with different content. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4634 - Studies in an American Author before 1900 (3 credits)
This course examines the life, work, and critical reception of a single major American author (or a pair of closely associated authors) writing before 1900. May be taken up to three times with different content. Junior standing is required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4644 - Studies in an American Author after 1900 (3 credits)
This course examines the life, work, and critical reception of a single major American author (or pair of closely associated authors) writing after 1900. May be taken up to three times with different content. Junior standing is required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4664 - Contemporary Fiction (3 credits)
Fiction since 1945 with emphasis upon the most recent two decades: the late modernist narratives of Bellow, Updike, and Percy; the new fiction of Barth, Hawkes, Barthelme; the postmodern fiction of Federman, Carter, Fowles, Katz, Sukenick.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4684 - Special Topics in Literature (3 credits)
An advanced, variable-content course which explores a significant or emergent literary issue or approach, or a body of literature. May be taken twice with different content.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4704 - Advanced Creative Writing: Fiction (3 credits)
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on skills students have acquired in creative writing workshops. Primary focus is on the writing and critiquing of original fiction, while paying close attention to the work of established writers who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own fiction.
Prerequisite(s): ENGL 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4714 - Advanced Creative Writing: Poetry (3 credits)
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on the skills acquired in previous creative writing workshops. Primary focus is on the writing and critiquing of original poems, while paying close attention to the work of established poets who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own poetry.
Prerequisite(s): ENGL 3714
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4724 - Creative Writing: Fiction for Young People (3 credits)
This course is conducted in a workshop setting in which students compose original stories for young people. Elementary techniques of fiction are emphasized, such as plot structure, point of view, setting, characterization, and audience. Must have prerequisites or permission of the instructor.
Prerequisite(s): ENGL 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4744 - Editing an Undergraduate Research Journal: Philologia (3 credits)
A seminar and professional development course on editing and producing a scholarly research journal. Emphasis on the day-to-day production operations of a research journal; the analysis, evaluation, and editing of manuscripts; journal design and layout; website content development; development and distribution of promotional materials; and the production of editorial exchange with authors.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4754 - Editing a Literary Journal (3 credits)
An experiential learning and professional development course on the history and day-to-day operations of literary journal editing with emphasis on composing blog posts and promotional materials, analyzation of the history of print culture, analyzation of current publications, the practice of copyediting and developmental editing, the evaluation of manuscripts for inclusion in a literary journal, the evaluation of job opportunities, and the composition of application materials.
Prerequisite(s): ENGL 1106 and ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4764 - Small Press Publishing (3 credits)
A seminar and professional development course on the history and day-to-day operations of small press culture and production. Emphasis on the design and distribution of promotional materials; the analysis, evaluation, and editing of manuscripts; and practice the art of editorial exchange with authors. Evaluation of job opportunities and composition of application materials. May be repeated 2 times with different content for a maximum of credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4784 - Senior Seminar (3 credits)
Designed for senior English majors, this is a variable topics, in-depth study of a particular issue or theme in language or literature. This capstone course aims to integrate and synthesize previous work in the discipline, focusing especially on close reading, research, and writing skills.
Prerequisite(s): ENGL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4804 - Grant Proposals and Reports (3 credits)
This course prepares students to write effective proposals, reports, and informational articles. Students learn to define and write problem statements, program objectives, plans of action, evaluation plans, budget presentations, and summaries. In addition, they sharpen their teamwork, editing, writing, audience awareness, and design skills as they engage in collaborative projects with campus and/or non-profit organizations in the community. Prerequisite or consent of the instructor is required.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4814 - Developing Online Content (3 credits)
Covers the process of creating documents for online environments. Builds on knowledge and skills acquired in foundational Professional Writing courses. Involves production of websites from scratch, starting with low-fidelity mockups and advancing to formatting layouts adaptable to the diverse screen sizes of computers and mobile devices. Focuses on a balance of structure (code), content (information), and format (presentation and design).
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4824 - Science Writing (3 credits)
Writing in and about the natural and social sciences. Students will write documents such as abstracts, research proposals, and ethnographies, analyze the development of disciplinary writing practices, and study non-fiction science writing for general audiences. Senior standing or instructor approval required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4854 - Writing, Research, Study Abroad (3 credits)
Application of academic abroad experience to students disciplinary studies on campus. Conducted after international education abroad experience. Collaborative writing and research projects as well as individual, independent research. Approval of course instructor required. Open to all majors. Pre-requisite: A formal study abroad educational experience; department approval.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4874 - Issues in Professional and Public Discourse (3 credits)
In this course designed for English majors in the Professional Writing Option, students will focus on the ways in which scientific, technical, and professional communication influence, and are influenced by, public discourse. Drawing on strategies of rhetorical criticism, students will gain an understanding of the persuasive value of style, arrangement, and delivery by investigating their professional roles in helping to structure public debate. Pre: Completion of at least 9 credit hours from the following courses: 2844, 3104, 3474, 3804, 3814, 3824, 3834, 3844, 4474, 4804, 4814, 4824.
Prerequisite(s): ENGL 3104 or ENGL 2844
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4954 - Study Abroad: Issues and Texts (1-6 credits)
An advanced, variable-content and multi-disciplinary course that explores global themes and literature(s) during a month-long, faculty-led summer study abroad experience. Pre-requisite: Junior Standing required. Variable credit course, repeatable up to 6 credits.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

ENGL 4954B - Study Abroad (1-6 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ENGL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Entomology (ENT)

ENT 2004 - Insects and Human Society (3 credits)
Past, present, and future role of insects in human society. Insect biology, diversity, and identification of common insects and other arthropods. Effects of insects on disease transmission, global food security, and human health. Management of pests of plants, animals, insects as food, and its effects on environmental pollution. Critique popular science communication and its effect on public policy. Human perceptions of insect conflicts, benefits of insects, and arthropod conservation across the world.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 2254 - Bees and Beekeeping (2 credits)
An introduction to honey bee biology, the social organization of the honey bee colony and to modern apiculture, including the use of bees for pollination. Topics on beekeeping include equipment, how to get started, and colony management practices. II
Instructional Contact Hours: (2 Lec, 2 Crd)

ENT 2264 - Bees and Beekeeping Laboratory (1 credit)
A laboratory course which examines the principles and practices of modern apiculture as they relate to honey bee biology. An emphasis is placed on students gaining practical field experience in modern management techniques. II
Corequisite(s): ENT 2254
Instructional Contact Hours: (3 Lab, 1 Crd)

ENT 2804 - Bees: Biology, Diversity, and Sustainability (3 credits)
Foundational introduction to bees. Behavior, communication, and social organization of honey bees; diversity and use of alternative (non honey bee) pollinators; scientific inquiry in ecosystem services management; and current global challenges to and sustainable solutions for pollination in the modern-day agricultural landscape.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 3014 - Insect Biology (2 credits)
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: BIOL 3014

ENT 3024 - Insect Biology Laboratory (2 credits)
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required. I
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): ENT 3014
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: BIOL 3024

ENT 3254 - Medical and Veterinary Entomology (3 credits)
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 3254

ENT 3264 - Medical and Veterinary Entomology Laboratory (1 credit)
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group.
Prerequisite(s): (BIOL 1105 and BIOL 1106) or (BIOL 1005 and BIOL 1006) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): ENT 3254
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: BIOL 3264

ENT 4254 - Insect Pest Management (3 credits)
Principles of insect pest management with application to the major insect pests found in Virginia. Pest management involves the utilization of all effective control practices in a program which is ecologically and economically efficient. This course is intended for all students with an interest in efficient agricultural production and in reducing losses to our most diverse competitor. One year of General Biology required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ENT 4264 - Pesticide Usage (3 credits)
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: PPWS 4264

ENT 4354 - Aquatic Entomology (4 credits)
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organism in aquatic ecology, pollution monitoring, and natural resource management.
Prerequisite(s): (BIOL 1005 and BIOL 1006) and (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106 and BIOL 1115 and BIOL 1116)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4354

ENT 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4484, FIW 4484

ENT 4624 - Animal and Plant Biosafety and Biosecurity (3 credits)
A One Health approach to the concept of biosafety and biosecurity. Principles, tools and techniques of disease detection, early warning, and containment of animal and plant pathogens. Regulatory agencies and guidelines that work to protect human, animal, plant, and environmental health and prevent economic and public health disasters. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Environmental Science (ENSC)

ENSC 1015 - Foundations of Environmental Science (3 credits)
Interrelationships between human activities and the environment; emphasis on biological, chemical, and physical principles that govern the flow of energy, materials, and information among physical, ecological and human systems.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 1016 - Foundations of Environmental Science (3 credits)
National and global perspective on societal concerns about the environment and human sustenance, including agriculture. Emphasizes the relationship between human systems and natural systems; ecosystem services and land, water and atmospheric resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 3134 - Soils in the Landscape (3 credits)
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ENSC 3604 - Fundamentals of Environmental Science (3 credits)
Interrelationships between human activities and the environment; provides national and global perspective; emphasis is on the physical, chemical, and biological principles and processes that are essential to an understanding of human-environment interactions; the role of energy in human and natural systems; environmental legislation and human behavior.
Prerequisite(s): BIOL 1105 or CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3634 - Physics of Pollution (3 credits)
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3644 - Plant Materials for Environmental Restoration (3 credits)
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils.
Prerequisite(s): BIOL 1106
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: BIOL 4164

ENSC 4244 - Ecological Restoration (3 credits)
Process of assisting the recovery of degraded ecosystems by linking ecological concepts to restoration interventions. Invasive species management, revegetation methods, soil and water quality, faunal restorations. Restoration project design, planning, monitoring and implementation.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4314 - Water Quality (3 credits)
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies.
Prerequisite(s): MATH 1026 or MATH 1226 and (BIOL 1105 or BIOL 1106) and (CHEM 1035 or CHEM 1036)
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4324 - Water Quality Laboratory (1 credit)
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314.
Prerequisite(s): CHEM 1046
Corequisite(s): CSES 4314, ENSC 4314
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: CSES 4324

ENSC 4344 - Ecological Restoration Field Practicum (2 credits)
Hands-on experience in planning ecological restoration projects, designing ecological restoration strategies, preparing degraded sites for restoration, managing invasive species in ecological restoration projects, implementing ecological restoration techniques, and monitoring restoration outcomes in degraded sites. Additional topics include adaptive management, stakeholder relationships, effective communication in ecological restoration projects, and challenges and barriers to restoration success.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (2 Lec, 2 Crd)

ENSC 4414 - Monitoring and Analysis of the Environment (2 credits)
Provides comprehensive hands-on-laboratory-and field-based experience and information on the principles and methods for field monitoring and sampling, as well the physical, chemical, and biological analysis of soil, surface water, groundwater, and solid wastes within the context of regulatory compliance. Optional 40-hour Hazards Materials (HAZMAT) training will be available. Senior standing required.
Prerequisite(s): (ENSC 3604 or ENSC 4314 or CSES 4314 or BIOL 4004) and (MATH 1026 or MATH 2015 and CHEM 1036 and BIOL 1105)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ENSC 4444 - Managed Ecosystems, Ecosystem Services, and Sustainability (3 credits)
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior or Senior Standing required.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 4444

ENSC 4734 - Environmental Soil Chemistry (3 credits)
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 and CSES 3124 or ENSC 3124 or GEOS 3624 and CHEM 2514 or CHEM 2535 and CHEM 2114 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 4734

ENSC 4764 - Bioremediation (3 credits)
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4774 - Reclamation of Drastically Disturbed Lands (3 credits)
Remediation, rehabilitation, revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and materials analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134 or CSES 3304 or GEOG 3304 or GEOS 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4864 - Captstone: Env Science (1 credit)
Discussion based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan. The work plan will demonstrate the students understanding of contaminant fate and mobility in different environmental media and will be defended orally. Review and explore available careers in environmental science through seminars and working groups within environmental professionals discussing the role and responsibilities of environmental scientists in industry, consulting, regulatory agencies, and non-profits. ENSC majors only. Senior Standing.
Prerequisite(s): (CSES 3634 or ENSC 3634) and (ENSC 4414) and (CHEM 4734 or CSES 4734 or ENSC 4734) and (CSES 4854 or ENSC 4854)
Instructional Contact Hours: (3 Lab, 1 Crd)

ENSC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Family and Consumer Science (FCS)

FCS 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Fashion Merchandising & Design (FMD)

FMD 1204 - Clothing and People (3 credits)
The study of the influence of culture and society on dress and dress practices, similarities and differences in the dress among groups and individuals, and the role of dress in reflecting and shaping intra- and inter-cultural interactions. The analysis of the construction and communication of personal and social identity (based on age, physical disability, gender, sex, sexual identity, race, ethnicity, religion, cultural and group/subcultural affiliations, etc.) through dress (clothing, accessories, body modifications) using fashion and social science theories and the intersection of various identities and positions in shaping human experience related to dress and appearance. Examination of diversity, equity, inclusion, and social justice issues and solutions related to dress and appearance within the United States and the global fashion industry.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 1224 - Introduction to the Fashion Industry (3 credits)
Development, structure and operations of textile and apparel manufacturers, marketers and retailers in the fashion industry and the product types including menswear, womenswear, childrenswear and accessories. Identification of fashion careers and major fashion markets and vendors both domestic and international. Basic processes and principles governing forecasting fashion acceptance, movement and change as influenced by economic, sociological, psychological, political and technological factors. Sources of industry information such as trade journals, industry websites and company publications.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 2014 - Digital Drawing (3 credits)
Basic principles and methods for digital drawing with consideration toward diverse populations in the global marketplace. Practice and skill development using a variety of computer tools to express design ideas via digital rendering by targeting diverse populations and understanding current global challenges. Hands-on experience via design projects.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 2204 - Introduction to Textiles (3 credits)
Structure, properties and basic production of textiles and textile components: natural and manufactured fibers; yarns; woven, knit, nonwoven fabrics; mechanical and chemical finishes; colorants and coloration methods. Influence on performance of apparel and interior textile products. Sophomore standing and one semester of Pathways Concept 4 (Reasoning in the Natural Sciences) is required.
Corequisite(s): FMD 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 2214 - Apparel Textiles Laboratory (1 credit)
Identification and characterization of textiles and textile components including: fabrics, finishes and coloration. Influence of these structural parameters on performance of apparel textiles. Sophomore standing and one semester of Pathways concept 4 (Reasoning in the Natural Sciences).
Corequisite(s): FMD 2204
Instructional Contact Hours: (3 Lab, 1 Crd)

FMD 2224 - Fashion Presentation Techniques (3 credits)
Basic principles and methods for executing fashion illustrations, proportions of the fashion figure, design details, portfolio development, identifying target markets and fabric renderings with consideration toward diverse populations in the global marketplace. Exploration and practice in color with work in pencil, color pencil, pastel, and watercolor. Practice and skill development using a variety of manual and computer tools to illustrate construction details and create technical flats. Emphasis placed on the use of correct industry terminology.
Prerequisite(s): AHRM 1014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 2264 - Apparel Product Development (3 credits)
Study of the pre-production stage of product development in the apparel industry, including planning a line based on market, consumer, and product research, forecasting trends in color, style and materials, developing and selecting designs and styles, and wholesale marketing of a line to retail buyers. Also includes the use of diverse inspiration sources for creating a design, application of computer-aided design to design and style development, and identification of career opportunities and qualifications for professional positions in the industry. Sophomore Standing required.
Prerequisite(s): FMD 2224
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 3024 - History of Costume (3 credits)
Study of the evolution and development of Western costume for adults and children from ancient times to the present with a focus on historical, socio-cultural, political, economic, and psychological factors/influences on changes in fashion and design style features. Use of terminology to describe each period's fashion and clothing design style features. Evaluation of similarities and differences between fashion and clothing design style features of different time periods. Discussion of theories of fashion change and fashion revival theories that explain the revival/reoccurrence of features of historic costume styles in contemporary fashion and design.
Prerequisite(s): FMD 1204 and FMD 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3034 - Historic Costume and Textile Collection Management (3 credits)
An active learning approach to managing and digitizing historic costume and textile collections; conserving historic textiles; and designing and curating historic costume and textile exhibitions. Researching, documenting, interpreting, handling and storing artifacts. Mounting and displaying a professional costume and textile exhibit appropriate for general public viewings and sharing via oral or poster presentations. Community-engagement methods. Design Lab/Studio
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 3104 - Fashion Retailing Concepts (3 credits)
Detailed investigation and analysis of the fundamentals of fashion merchandising concepts emphasizing problem solving at the retail level. Prerequisite: one semester of Pathways Concept 5 (Quantitative and Computational Thinking) required. Pre: Junior Standing.
Prerequisite(s): FMD 1224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3204 - Introduction to Textile Evaluation (3 credits)
Analysis of the performance properties of fabrics. Importance of evaluation to product development, quality control, and specification of care requirements.
Prerequisite(s): FMD 2204 and FMD 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3224 - Apparel Assembly (3 credits)
Systematizing and assembling garment applications for the apparel industry. Conceptual study of simple to complex apparel construction techniques, stitch and seam types, cost-effective measures, applications with manual manipulation, computers, tools, and equipment.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3234 - Pattern Drafting for Apparel (3 credits)
Apparel product development using basic and advanced flat pattern drafting techniques and skills. Concepts and application of specifications, flat pattern drafting techniques, garment fit and alteration, pattern grading, and marker layout principles used in apparel engineering, product development, and production, along with the development of skill in using a variety of related manual and computer tools.
Prerequisite(s): FMD 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3244 - Small Business Apparel Retail Development (3 credits)
Comprehensive study of small business concepts as applied to the textile and apparel retail industry. Analysis of the entrepreneurial mindset and strategies for business entry with emphasis on small business development, including concept and opportunity identification, merchandising and management, operations and control, advertising and promotion, and financial planning for a textile and/or apparel retail business.
Prerequisite(s): FMD 2264 and FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3264 - Draping (3 credits)
Study and application of basic and advanced draping techniques for patternmaking in the apparel industry, including darts in skirts and bodices, princess lines in bodices, yokes, pleats and gores in skirts, and asymmetrical structures for whole garments; selection of fabrics appropriate for garment styles; evaluation of garment fit, design and construction. Includes students design and construction of garments suitable for juried design competitions or exhibitions. Design Lab/Studio. Pre: Junior Standing
Prerequisite(s): FMD 3224
Instructional Contact Hours: (5 Lab, 3 Crd)

FMD 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4014 - 3D Digital Apparel Design (3 credits)
Implement design solutions using technologically advanced software to create styling on avatars with photorealistic 3D rendering. Transform skills acquired in digital illustration and flat pattern drafting courses into comprehensive tools to create real-life simulated garments. Manipulate or create digital assets (flat patterns, fabric, stitching, trim, etc.) to produce an original style for digital portfolio. Design Lab/Studio (2H, 2L,3C)
Prerequisite(s): FMD 2264 and FMD 3234
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 4024 - Portfolio (3 credits)
The development and production of a professional apparel portfolio in both paper and ePortfolio format. Pre: Senior Standing required; 3234 or permission of the instructor.
Prerequisite(s): FMD 3234 or FMD 3264
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4034 - Historic Costume and Textile Collection Management (3 credits)
An active and experiential learning approach to historic costume and textile collection management, including describing collection scope, policies, and organizational systems, selecting appropriate basic preservation and conservation techniques used for the care of historic clothing and textiles related to controlling the environment, handling and storage, and cleaning, using standard museum practices when accessioning, dating, labeling, cataloging, mounting/mannequin dressing, and photographing textile artifacts, developing methods for community engagement, and designing and installing historic dress exhibitions. Design Lab Studio.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 4124 - Clothing Behavior Patterns (3 credits)
Study of clothing behavior of individuals in relationship to their needs, values, attitudes, interests, and self-concepts. Overview of principles and theories related to individuals emotional, mental, and physical activities when obtaining, using, maintaining, and disposing of apparel products so as to satisfy their needs and desires. Application of principles and theories related to clothing behavior to the analysis of consumer and the development of effective merchandising strategies.
Prerequisite(s): FMD 3104 and (PSYC 1004 or SOC 1004)
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4134 - Fashion E-Tailing (3 credits)
Analysis of technologies, consumer trends, and strategies in fashion e-tailing. Identification of merchandising models, major features, challenges, and trends in fashion e-tailing, including big data, virtual and augmented technologies, and mobile- and social-commerce. Development of a strategic plan for an online fashion venture.
Prerequisite(s): FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4214 - Economics of the Textile and Apparel Industry (3 credits)
Study of the various segments of teh textile and apparel industry. Analysis of the market structure and functioning of each segment and of factors currently affecting the industry.
Prerequisite(s): (AHRM 2204 or FMD 2204) and (ECON 2006 or ECON 2006H) or (AAEC 1005 and AAEC 1006)
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4224 - Fashion Analysis and Communication (3 credits)
Functions of fashion analysis, promotions, forecasting, media, and communications in the fashion industry. Assessment of effective promotional activities based on consumer, market, and trend research of fashion products. Development of fashion promotion, forecasting, and communication plans. Pre: Senior standing.
Prerequisite(s): FMD 2264
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

FMD 4234 - Apparel Quality Evaluation (3 credits)
Study of quality of ready-to-wear apparel and factors that influence variations in the aesthetic and functional performance of the end product, including consumer perceptions and expectations, manufacturing processes and trends, and the physical components of the end product.
Prerequisite(s): FMD 3204 and FMD 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4244 - New York Fashion Study Tour (3 credits)
Integrative study of methods of operating at all levels within the fashion industry. Special emphasis on design, merchandising, and promotional activities. Seminars on campus and at pre-arranged appointments during a five-day stay in New York. AHRM major; Junior standing. Twelve hours of AHRM/FMD courses required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4264 - Fashion Merchandising and Design Strategies (3 credits)
Analysis of consumer characteristics as part of a forecast/market study to prepare new fashion merchandise lines based on key findings from forecasts. Formulate a financial merchandise plan using measures of profitability and pricing and devise financially beneficial marketing communications. Compare and contrast career choices through self-evaluation within the fashion apparel industry.
Prerequisite(s): FMD 3104 and FMD 3204 and FMD 3224 and FMD 4224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4274 - International Sourcing of Apparel Products (3 credits)
Study of international sourcing of apparel products through a simulation of the sourcing production to illustrate the procedures and factors needed to source apparel abroad and interrelationships among suppliers, retailers and consumers in the global apparel supply chain. Examination of social, economic, political, cultural, ethical, and environmental factors, law and trade barriers that influence a sourcing decision of apparel products abroad.
Prerequisite(s): FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4964H - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Finance, Insurance, and Business (FIN)

FIN 2114 - Investments and Financial Literacy (3 credits)
Examines budgeting; taxes; long- and short-term borrowing; credit card debt; student loan debt; ethical issues in both lending and investments; insurance; the investment process; the financial markets; investing in common stock, bonds, and mutual funds; major financial decisions, and retirement planning. Coverage of time value of money and risk and return will provide fundamental tools for valuation and financial decision-making.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 2164 - Survey of Finance and Career Planning (1 credit)
Career opportunities and job search strategies in the finance field with reference to the finance courses that best help the student identify a career in his/her selected field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

FIN 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. Pre: Instructors consent and the completion of 30 SH with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

FIN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 3054 - Legal and Ethical Environment of Business (3 credits)
This course examines the legal and ethical environment in which businesses operate. Topics include legal systems, dispute resolution, torts, contracts, agency, employment, business forms, property, ethical theories, decision-making and other selected subjects. Emphasis is placed on problem solving through the application of principles and reasoned analysis. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3074 - Legal, Ethical, and Financing Issues for Entrepreneurs (3 credits)
Introduction of key legal, ethical, and financing topics for new ventures. Ethical decision making in entrepreneurial situations. Choosing among legal entities for financing and ownership goals. Company governance. Creating and protecting intellectual property. Identifying and choosing financing options for new ventures. Employment issues for entrepreneurial firms. Basics of contracts. Enterprise risk management and compliance. Exit strategies. Partially duplicates FIN 3054 (Legal and Ethical Environment of Business). Students may not receive credit for both courses. Sophomore Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3104 - Introduction to Finance (3 credits)
Overview of financial decision-making process focusing on the creation of wealth. Topics covered include the time value of money, how stocks and bonds are valued, financial decision-making within a firm, an overview of financial markets, and investment banking. The course is designed for finance and non-finance majors.
Prerequisite(s): (ACIS 2115 and ECON 2005 and BIT 2405) or (ACIS 2115 and ECON 2005 and CMDA 2005) or (ACIS 2115 and ECON 2005 and STAT 3005) or (ACIS 2115 and ECON 2005 and STAT 3604) or (ACIS 2115 and ECON 2005 and STAT 3615 and STAT 3616) or (ACIS 2115 and ECON 2005 and STAT 4604) or (ACIS 2115 and ECON 2005 and STAT 4705 and STAT 4706) or (ACIS 2115 and ECON 2025H and BIT 2405) or (ACIS 2115 and ECON 2025H and CMDA 2005) or (ACIS 2115 and ECON 2025H and STAT 3005) or (ACIS 2115 and ECON 2025H and STAT 3604) or (ACIS 2115 and ECON 2025H and STAT 3615 and STAT 3616) or (ACIS 2115 and ECON 2025H and STAT 4604) or (ACIS 2115 and ECON 2025H and STAT 4705 and STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3114 - Python/SQL for Data Analytics and Finance (3 credits)
A foundation in Python/SQL and the tools needed to implement a data-driven approach to financial problem solving. Emphasis on accessing external databases, merging databases, manipulating and transforming data, performing operations, generating an output or another dataset, and exporting in a readable or visual form. To prepare students to analyze datasets for making financial decisions.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3124 - Financial Planning for Professionals (3 credits)
Analysis of financial needs, from the context of the individual, household or small business owner, related to financial situation (cash management and use of debt), income taxes, risk management, retirement planning, investment planning, estate planning, and other special needs. Utilizes mathematical and computing skills. FIN 3134 may be taken prior to or concurrent with course. Sophomore Standing required.
Corequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3134 - Financial Analytics (3 credits)
This course provides an understanding of the theory and practice of making financial decisions for corporations through the understanding of relevant data and applying computational and statistical methodologies to decision making. Topics include the time value of money, risk and return, security valuation, and interest rate determination. Some key concepts and computational and statistical modeling are completed in Excel. Pre: Sophomore standing.
Prerequisite(s): FIN 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3144 - Investments: Debt, Equity and Derivatives (3 credits)
Risk, return and portfolio modeling theory, knowledge of financial securities and markets and the information and data contained within them. Introduction to mutual funds, financial securities, and markets. Application of financial computation and modeling through portfolio analysis, market efficiency and performance evaluation, bond valuation, term structure of interest rates, interest rate risk, security analysis and stock valuation, options, Black-Scholes option pricing model, and futures. Pre: Sophomore standing.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3154 - Corporate Financial Analytics and Strategy (3 credits)
This course provides the understanding of the types of financial management decisions that firms make, the environment in which decisions are made, the available choices and decision criteria, and valuation consequences of these choices through financial analytical modeling. Determination of a firm's optimal debt- equity ratio, estimation of cost of capital, evaluation of capital investments, payout policies, merger and acquisition decision-making, and sources of financing with emphasis on identifying and mitigating potential agency conflicts. Pre: Sophomore standing.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3174 - Finance Career Strategies (1 credit)
Analysis and research of career opportunities in financial industry. Study of future trends in careers in financial industry. Development of short and long-term career goals. Building and developing a professional network. Identify types of finance interviews. Ethical negotiation of job offers.
Instructional Contact Hours: (1 Lec, 1 Crd)

FIN 3204 - Risk and Insurance (3 credits)
Surveys the concept of risk as it applies to the nuclear family and as a socio-economic force in society. Risk management techniques utilizing social and proprietary insurance to neutralize the effect of risks inherent in daily life: termination or suspension of earnings, liability exposures, and potential losses of real and personal property values. Sophomore Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3254 - Credit Risk Analysis (3 credits)
Analysis of the risks inherent in credit/lending decisions. Pricing of loans, appropriate documentation, and monitoring of the creditworthiness of businesses and individuals. Emphasis on making credit decisions and structuring of credit agreements.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4004 - Wills, Trusts, and Estates (3 credits)
Examines the control of assets through the creation and use of trusts, and the control of property through estate planning. The course emphasizes financial planning through estate management both personally and as a part of a business plan.
Prerequisite(s): FIN 3054 or FIN 3074
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4014 - Cyberlaw and Policy (3 credits)
Cyber law, ethics, and policy in a changing world. National and international methods of regulation and protection of fundamental rights. Legal, ethical, and policy issues for Internet governance, speech, privacy, cybersecurity, surveillance, electronic commerce, intellectual property, and cyberwar. Examination of current issues and texts in light of fundamental ethical and legal principles and global discourse. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4024 - Legal and Regulatory Aspects of ESG (3 credits)
Examines the legal and regulatory issues raised by Environmental, Social, Governance (ESG) aspects of investments and corporate finance. Specific attention is given to ESG's effect upon traditional corporate law principles, reporting and regulatory frameworks.
Prerequisite(s): (FIN 3054 or FIN 3074) and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4104 - Retirement Planning (3 credits)
Overview of planning needs, products, and strategies used by financial professionals to help businesses, small business owners, and individuals choose and implement an effective retirement plan. Must have prerequisite or permission of instructor.
Prerequisite(s): (FIN 3124 and ACIS 4344) or (FIN 3134 and ACIS 3314)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4114 - Financial Planning Technology and Modeling (3 credits)
Use of professional software applications that support financial planning analyses, plan preparation, wealth management, and client relationships. Principles of personal investment portfolio research, construction, and performance applied to comprehensive financial planning and wealth management.
Prerequisite(s): FIN 3124 and FIN 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4124 - Client Relationship Management (3 credits)
Investigation of socio-psychological factors and communication/ interviewing strategies that foster trust-based relationships essential to the success of financial advisors and other financial service professionals. Graduate students are expected to have completed AAEC 3104 or FIN 3124 or an equivalent course or may enroll with permission of the instructor.
Prerequisite(s): FIN 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4134 - Financial Planning Applications (3 credits)
Integration of financial planning content in the resolution of client situations in the context of ethical and compliant workplace practices. Utilizes a case analysis approach applying financial planning processes and procedures. Graduate students are expected to have similar background from equivalent courses or professional experience or may enroll by permission of the instructor. ACIS 4344 or FIN 4004 taken simultaneously with the course can be substituted for the prerequisites.
Prerequisite(s): FIN 3124 and FIN 3144 and FIN 3204 and ACIS 4344
Corequisite(s): FIN 4104, FIN 4114, FIN 4004
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4144 - International Financial Management (3 credits)
Explores the environmental challenges facing the financial manager of a multinational corporation and the tools and techniques developed to meet such challenges.
Prerequisite(s): FIN 3104 or FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4154 - Real Estate Finance (3 credits)
This course introduces the fundamentals of both real estate financing and investment. Conventional mortgages as well as more creative financing methods will be analyzed. The secondary market for mortgages and relevant institutional factors also will be examined. Investment analysis of real estate will be viewed in a capital budgeting framework; appropriate tax law will be discussed as it affects real estate cash flows.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4204 - Environmental, Social, and Governance Financial Analytics (3 credits)
Environmental, Social and Governance (ESG) factors impacting corporate investment and financing decisions. Analytical tools for incorporating ESG factors into various forms of financial analysis including capital budgeting, capital structure, financing decisions, and investment portfolio management.
Prerequisite(s): (FIN 3054 or FIN 3074) and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4214 - Financial Modeling in Excel (3 credits)
Concepts of finance applied to the construction of models in Excel. Construct models of financial statement to evaluate financial strategies for a firm; design risk/return models for investment portfolio strategies using equity and/or debt securities; build models to optimize bond portfolios including interest rate sensitivities, duration and convexity; develop models to analyze and dynamically hedge option and futures portfolios; assemble binomial tree models on American options; build simulation models to evaluate different types of options.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4224 - Fixed Income Securities: Analysis and Management (3 credits)
Analysis of fixed income securities, including corporate bonds, U.S. Treasury notes and bonds, municipal bonds, money market securities, and home mortgages. The analysis include interest rate risk, credit risk, bond valuation theory, and the valuation of embedded options in the bond contract. Theories of the term structure of interest rates are presented. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4225 - Analytics for Fixed Income Securities and Portfolio Management (3 credits)
4225: Management of fixed income securities in an experiential setting. Bond pricing and investment. Credit analysis and portfolio strategies in fixed income. Introduction to advanced analytical techniques in bond and portfolio analytics. Conduct research on individual companies, industries, and countries. Membership in BASIS (Bond And Securities Investing by Students). Must have a B- or better in prereq. Pass/Fail Only.
Prerequisite(s): FIN 3134
Corequisite(s): FIN 4224
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4226 - Analytics Fixed Inc. Port Mgmt (3 credits)
4226: Advanced management of fixed income portfolios in an experiential setting. Advanced credit analysis and modeling. Advanced analytical techniques for bonds and portfolios. Lead research teams. Research macroeconomic and international capital trends. Execute reports for internal and external distribution, especially for the clients. Membership in BASIS (Bond And Securities Investing by Students). Must have a B- or better in prereq. Pass/Fail Only.
Prerequisite(s): FIN 4224 and FIN 4225
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4234 - Venture Capital and Investment Banking (3 credits)
Explores the venture capital cycles of fund-raising, investing in portfolio firms, and exiting the investment. Focuses on the role of investment banking in the exiting of investments by taking the portfolio firms public through initial public offerings. Includes a conceptual component and an applied component in which the case method is used. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4244 - Asset Valuation and Corporate Governance (3 credits)
The effect of corporate governance on asset-valuation. Case oriented course focusing on the valuation of non-financial assets such as projects, business units, private and public firms. Topics include method of comparables, discounted cash flow methods and the real options approach to valuation. Examines the external and internal governance mechanisms for preserving and enhancing the value of a firm. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4254 - Bank Management and Financial Services (3 credits)
The functions of financial service providers and the risks inherent in the provision of banking and other financial services. Regulatory background and issues. Case oriented course. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4255 - Credit Corps Lending Practicum (3 credits)
Credit underwriting of commercial loans in an experiential setting. Project work spans two semesters. 4255: First project and basic management of cash flows on legacy portfolio of loans. Credit analysis of middle market companies leading to recommendations for lending to such companies. Research on individual companies, their industries, or on commercial real estate projects. Research on relative loan pricing, trends in leverage loan markets. Professional-level presentation of loan recommendations. Exhibit the highest ethical standards and confidentiality and maintain a high level of responsibility, initiative, and performance. 4256: Finalization of first 4255 project as needed. Continuation of credit analysis and research applied to companies in different three-digit industry code, advanced credit risk and financial modeling, loan portfolio management on legacy loans including takedown/paydown of revolving lines. Reporting for internal distribution and for sponsor.
Prerequisite(s): FIN 3254 and FIN 4254 or FIN 4244
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4256 - Credit Corps Lending Practicum (3 credits)
Credit underwriting of commercial loans in an experiential setting. Project work spans two semesters. 4255: First project and basic management of cash flows on legacy portfolio of loans. Credit analysis of middle market companies leading to recommendations for lending to such companies. Research on individual companies, their industries, or on commercial real estate projects. Research on relative loan pricing, trends in leverage loan markets. Professional-level presentation of loan recommendations. Exhibit the highest ethical standards and confidentiality and maintain a high level of responsibility, initiative, and performance. 4256: Finalization of first 4255 project as needed. Continuation of credit analysis and research applied to companies in different three-digit industry code, advanced credit risk and financial modeling, loan portfolio management on legacy loans including takedown/paydown of revolving lines. Reporting for internal distribution and for sponsor.
Prerequisite(s): FIN 4255
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4264 - Managing Risk with Derivatives (3 credits)
The types, payoff, and pricing of derivative securities and contracts and their application in managing financial risks faced by corporations. Topics include options, forwards, futures and swaps; managing foreign currency risk, interest rate risk, stock price risk, and commodity price risk; and risk management techniques. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4274 - Equity Securities: Analysis and Management (3 credits)
Advanced valuation and analysis of equity securities with case applications. Critical analysis of advanced equity asset pricing models. Analysis of advanced equity portfolio management techniques, equity portfolio performance measurement, and equity portfolio performance attribution analysis. Identification and analysis of market anomalies and recent developments in equity analysis. Must have grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4275 - Analytics for Equity Securities and Portfolio Management (3 credits)
Selection and management of equity securities in an experimental setting. Analysis, selection, and investment in common stocks. Introduction to advanced analytical techniques in equity evaluation and portfolio analytics. Research individual companies, industries, economic sectors, and national and global macroeconomic trends. Use appropriate software to develop financial models. Present buy and sell recommendations for actual execution in the portfolio. Maintain a high level of fiduciary responsibility. Pass/Fail only. Membership in SEED (Student-Managed Endowment for Educational Development).
Prerequisite(s): FIN 3134
Corequisite(s): FIN 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4276 - Analytics for Equity Securities and Portfolio Management (3 credits)
Advanced management of equity portfolios in an experiential setting. Equity valuation and investing in equity securities. Advanced equity valuation analysis and modeling. Conduct and take a leadership role on teams that research individual companies, industries, and sectors. Research macroeconomic and international capital trends. Lead a team to present buy and sell recommendations for the portfolio and/or construct reports on equity topics. Present buy and sell recommendations for actual execution in the portfolio. Exhibit the highest ethical standards. Mentor new SEED analysts. Pass/Fail only. Membership in SEED (Student- Endowment for Educational Development).
Prerequisite(s): FIN 4274 and FIN 4275
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4284 - Free Markets, Individual freedom, and Economic Welfare (3 credits)
Course exposes students to various viewpoints on the role free markets can and do play in promoting individual freedom. Allocation of scarce resources, and in enhancing welfare. Explores the strengths and weaknesses of capitalism by critically evaluating the relationship between the economic efficiency achieved by capitalism and the attainment of welfare objectives. Other topics include current items such as globalization, price controls, income equality, outsourcing, corporate pricing power though monopoly/oligopoly, and government regulation of the economy.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4294 - Commodity Invt. Portfolios (3 credits)
Application of fundamental commodity analysis and valuation techniques utilized to create a commodity investment portfolio in an experiential setting. Analysis, selection, and advanced analytical techniques in domestic and international agricultural, energy and metal commodities applied to a simulated investment in a commodity portfolio. Maintain a high level of fiduciary responsibility through developing, maintaining, and interpreting portfolio performance on a daily basis.
Prerequisite(s): FIN 3134 and FIN 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4314 - Field Projects in Finance (3 credits)
Finance-related business projects with external clients, which will include gathering and analyzing data, understanding relevant financial issues in a business context, formulating recommendations, and presenting analyses and recommendations in oral and written form. May be repeated once with different content for a maximum of 6 credit hours.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

FIN 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4984 - Special Study (1-19 credits)
Special Study
Instructional Contact Hours: Variable credit course

FIN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Financial Aid (FNAD)

FNAD 3900 - Study Abroad-Consortium Enroll (1-21 credits)
Instructional Contact Hours: (0 Lec, 1-21 Crd)

FNAD 3910 - Travel Activity (0 credits)
Instructional Contact Hours: (0 Lec, 0 Crd)

FNAD 3920 - Domestic Consortium (1-19 credits)
Instructional Contact Hours: Variable credit course

FNAD 3930 - International Autonomous (1-19 credits)
Instructional Contact Hours: Variable credit course

FNAD 3950H - Honors Travel Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

Fine Arts (FA)

FA 2004 - Creativity and the Artistic Experience (3 credits)
Examine how the arts intersect with our daily lives. Compose and create basic examples of abstraction and 20th century modernism. Trace the global influences and roots of our current culture. Explore the science of acoustics and its effect on performing spaces. Discuss the process of an arts performance. Apply themes of improvisation, creativity and how we process beauty. Investigate emerging brain science as it relates to art, beauty and pleasure. Identify the unique ways of knowing embodied in the arts distinct from scientific measurements. No prior knowledge of visual, theatrical or musical arts needed.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

Fish and Wildlife Sciences (FIW)

FIW 2114 - Principles of Fish and Wildlife Conservation (3 credits)
Basic principles, key people, agencies and laws guiding the science-based conservation and management of fish and terrestrial animals. Conservation and management of organisms, habitats, and human users examined in terms of biological, physical, ecological, ethical and sociological theories and practices. Local to global illustration from both recreational and commercial resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2234 - Fish, Fishing, and Conservation (3 credits)
Sensory perception, behavior, and consciousness in fish. Principles, as related to fish and why they matter, fish conservation ethics, food security, recreational fishing, and responsible fishing practices. Ethical reasoning applied to the contemporary issues of conservation and use of fish, such as subsistence fishing, fish farming, marine protected areas, highly migratory fishes, sharks tourism, and ornamental fishes.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2314 - Wildlife Biology (3 credits)
Summary of biological characteristics of wild birds and mammals, especially relating to management by humans. Physiological, functional, structural, and behavioral adaptations of individuals to their environments and foods.
Prerequisite(s): (BIOL 1105 or BIOL 1205H) and (BIOL 1106 or BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2324 - Wildlife Field Biology (3 credits)
Systematics, identification, and natural history of common native vertebrates and plants. Exposure to habitats/ecosystems of western Virginia. Observation, collection, and reporting of field data. Self-scheduled field and media lab activities required.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FIW 2334 - Urbanization and Biodiversity Conservation (3 credits)
Overview of challenges and opportunities that urban environments create for biodiversity conservation and human wellbeing, with a focus on social sciences theories and approaches. How urbanization is changing people's relationship with their environment and what that means for biodiversity conservation and human wellbeing. Examination of how data collection, analysis, and interpretation occur using social sciences methods applied to biodiversity conservation. Diversity, Equity, and Inclusion in the context of urbanization and conservation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2334

FIW 2514 - Fish and Wildlife Conservation Policy (3 credits)
Foundations of U.S. and Virginia fish and wildlife conservation policy (FWC), including international agreements. Ethical, religious, and legal foundations of FWC policy. Roles of values and beliefs in conservation behavior. Constitutional basis for FWC policy in the U.S. How FWC policies are made, implemented, and revised through state and federal agencies. Major conservation policy strategies, particularly the value of stakeholder collaboration for successful policy development, passage, and implementation. Conduct independent and group social science research to identify and present compelling policy solutions for an FWC problem.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 3514 - Fisheries Techniques (3 credits)
Application of field and laboratory methods in fisheries management and research. Experience with fisheries equipment and techniques.
Prerequisite(s): FIW 2114 and STAT 3615
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FIW 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 3954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

FIW 3954D - Study Abroad (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

FIW 3964 - Internship Through Directed Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

FIW 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4114 - Biodiversity Conservation (3 credits)
Advanced concepts and practices related to the conservation and enhancement of biological diversity. Understanding and analysis of causes of biological scarcity. Designing actions to mitigate biodiversity loss. Integration of legal, economic, social, and biological principles to develop solutions to conservation of organisms, populations and ecosystems. Cannot be taken for credit by Wildlife Conservation (WLC) majors.
Prerequisite(s): FIW 2114
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4214 - Wildlife Field Techniques (3 credits)
Field research methods for wild vertebrates in terrestrial environments. Application of research methodology including animal capture and marking, determination of sex, age, and condition, radio telemetry and map/compass/GPS orienteering, non-invasive methods of capture, habitat selection, and supervised group research projects. COURSE FEE $299.
Prerequisite(s): FIW 4414 and STAT 3615
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FIW 4244 - Applied Epidemiology of Fish and Wildlife Diseases (3 credits)
Theory and data analyses from veterinary epidemiology applied to fish and wildlife management. Biological sampling methods and data collection in fish and wildlife for epidemiological surveillance in free-ranging populations. Fish and wildlife epidemiology concepts, methods and applications for private, non-profit, academic, state, and federal agencies. Ethically measure, characterize, and forecast epidemics in fish and wildlife.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4314 - Conservation of Biological Diversity (4 credits)
Principles and practices of conserving biological diversity. Causes, consequences and rates of extinction. Application of philosophical, biological, sociological and legal principles to the conservation of genes, plant and animal species and ecosystems.
Prerequisite(s): FIW 4414 and FIW 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4324 - Genetics of Natural and Mangaged Populations (3 credits)
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology.
Prerequisite(s): BIOL 1105 and BIOL 1106 and (STAT 3005 or STAT 3615 or FREC 3214)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4324

FIW 4334 - Mammalogy (4 credits)
Biology of mammals, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography.
Prerequisite(s): BIOL 2704 or BIOL 2704H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4344 - Herpetology (4 credits)
Biology of amphibians and reptiles, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography.
Prerequisite(s): BIOL 2704 or BIOL 2704H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4414 - Population Dynamics and Estimation (3 credits)
Population growth, structure, and regulation of fish and wildlife populations including harvested populations, non-harvested populations, and small or declining populations. Methods of estimating demographic parameters such as population size, survival, and recruitment. Population viability analysis and genetic considerations in population dynamics.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4424 - Ichthyology (4 credits)
Morphology and physiology, systematics, zoogeography, and identification of fishes.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

FIW 4434 - Wildlife Habitat Ecology and Management (3 credits)
Relationship of wildlife species to their habitats. Factors influencing distribution and abundance of wildlife populations. Vegetation succession and structure, habitat classification, modeling wildlife habitat relationships and management of habitats in forests, agricultural lands, rangelands, riparian/wetland and urban areas.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4454 - Human-Wildlife Conflicts (3 credits)
Current and emerging human-wildlife interactions that lead to conflict; application of knowledge of animal behavior and life history, population dynamics, human dimensions, and ecosystem functions to analyze conflicts and formulate effective resolution; legal statutes and regulatory constraints on resolution; reliance on case studies of existing conflict situations to gain applied experience in diagnosing and solving human-wildlife conflicts using Vertebrate Integrated Pest Management protocols. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4464 - Human Dimensions of Fisheries and Wildlife (3 credits)
Values, attitudes, and opinions of people toward fish and wildlife. Social, economic, legal, and political aspects of fisheries and wildlife management. Roles of professionals and the public in fish and wildlife policy processes. Contemporary fish and wildlife policy issues. Senior standing required.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4474 - Wildlife Habitat Evaluation (1 credit)
Methods to evaluate habitat quality for selected wildlife species. Determining habitat characteristics important to a selected species. Developing a habitat assessment approach to estimate habitat quality. Measuring and quantifying habitat characteristics. Assessing effects of management actions and habitat alterations on a selected wildlife species. Applying habitat assessment models to guide management and mitigation decisions. Techniques for oral and written presentations. Restricted to Wildlife Conservation Majors.
Corequisite(s): FIW 4434
Instructional Contact Hours: (3 Lab, 1 Crd)

FIW 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4354 or BIOL 4004 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4484, ENT 4484

FIW 4534 - Ecology and Management of Wetland Systems (3 credits)
Introduction to the variety of wetland systems found in North America, though emphasis will focus on eastern and mid-Atlantic wetland systems. Origin and processes of formation of wetlands, functions and values of wetlands, wetland delineation, wetland classification, regulatory processes affecting wetlands. Objectives of and management techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Enrollment restricted to junior, seniors and graduate students.
Prerequisite(s): BIOL 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FIW 4614 - Fish Ecology (3 credits)
Interactions of fish with the physical and biological environment. Adaptations of organisms, populations, and communities. Impacts of human activities on major aquatic ecosystems and important fishes. Ecological principles for management of important sport, commercial, and prey fishes.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4624 - Marine Ecology (3 credits)
Marine organism, biological, ecological, chemical and physical processes of marine ecosystems in open sea, coastal and benthic environments, research methods and models in marine ecosystem simulation; fisheries in a dynamic ecosystem: human interference and conservation.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4714 - Fisheries Management (4 credits)
History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management and setting management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries.
Prerequisite(s): FIW 3514
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Food Science and Technology (FST)

FST 2004 - Exploring Food Science Careers (1 credit)
Food science specialization areas and career opportunities. Experiential learning opportunities developed through bridge experience platform. Introduction to research, internship, study abroad and individualized learning. Career preparation, job and internship search strategies.
Instructional Contact Hours: (1 Lec, 1 Crd)

FST 2014 - Introduction to Food Science (2 credits)
Fundamentals for food science and technology. Integration of basic principles of food safety, human nutrition, food spoilage, and sensory evaluation with the appropriate technology of food preservation and processing.
Instructional Contact Hours: (2 Lec, 2 Crd)

FST 2024 - From Raw to Burnt: Exploring Science and Society through Foods (3 credits)
Food as a method of studying scientific principles and development of society, including acquiring, preserving, processing and consuming foods. Integration of chemistry, biology and physics of grains; salt and spices; meat, poultry, and fish; dairy and eggs; fruits and vegetables; and fat and oils, with the advancements in and the cost to human civilization from historical and ethical perspectives of food production. Scientific principles demonstrated in food preparation.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2044, PSCI 2044

FST 2244 - Topics in Food Science and Technology (1-3 credits)
Variable topics in food science and technology such as emerging trends, challenges and regulatory policy. Qualitatively and quantitatively explore relevant and timely issues facing food systems. May be repeated for a maximum of six credits with different topics. Pre: Sophomore standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

FST 2424 - Introduction to Food and Beverage Fermentation (3 credits)
Principles, processes, and applications of fermentation in the context of food and beverage production. Explores various fermentation techniques, the chemical processes and microbiology involved, and the role of fermentation in enhancing flavor, texture, preservation, and nutritional value. Hands-on experience through workshops and sensory evaluation.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 2544 - Functional Foods for Health (3 credits)
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2544

FST 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 3024 - Principles of Sensory Evaluation (3 credits)
Principles of sensory evaluation including theory, sensory physiology and psychology, experimental methods, applications, and statistical analysis.
Prerequisite(s): STAT 3005 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 3114 - Wines and Vines (3 credits)
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 3114

FST 3124 - Brewing Science and Technology (3 credits)
Study of chemical reactions important in brewing of beer and hard cider. Effects of variations in malting, mashing, and other processing steps on characteristics and quality of beer; fruit sugar, acid and fermentation impacts on cider composition and quality. Investigation of reactions that cause flavor deterioration.
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 3214 - Principles of Meat Science (3 credits)
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations.
Prerequisite(s): ALS 2304 and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 3214

FST 3514 - Food Analysis (4 credits)
Data analysis, sampling techniques, theory and practice of chemical and physical methods of food analysis for determination of food composition; application of analytical methods of quality control and food laws and regulations.
Prerequisite(s): (STAT 3615 or BIT 2405) and (CHEM 2535 or CHEM 2514)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FST 3604 - Food Microbiology (4 credits)
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Method to enumerate, identify, and characterize microorganisms in foods.
Prerequisite(s): BIOL 2604 and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 3604

FST 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

FST 4004 - Food Science Experiential Learning Reflection (1 credit)
Reflection of skills and knowledge developed during food science experiential learning process. Analyze curriculum. Development of communication skills to reflect and evaluate their experience.
Instructional Contact Hours: (1 Lec, 1 Crd)

FST 4014 - Concepts of Food Product Development (3 credits)
Application to the food industry of principles and standard practices of research and product development; functionality of food ingredients; students will work in teams to design and develop a new food product.
Prerequisite(s): FST 3604
Corequisite(s): FST 4405, FST 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4104 - Applied Brewing Science and Engineering (3 credits)
Chemistry, biochemistry, and engineering aspects of brewing operations in the production of beer. Barley, malting, hops, brewing operations, fermentation chemistry, yeast characteristics and finishing operations examined. Calculations of raw materials, brewing and fermentation schedules, and final specifications conducted. Laboratory exercises focused on brewing, brewery engineering, and analysis of intermediate and final products.
Prerequisite(s): FST 3604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FST 4204 - Advanced Topics in Food Science and Technology (1-3 credits)
Variable advanced topics in food science and technology such as emerging trends, challenges and regulatory policy. Qualitative and quantitative exploration of relevant and timely issues facing food systems. May be repeated for a maximum of six credits with different topics. Pre: Junior standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

FST 4304 - Food Processing (3 credits)
Basic principles of unit operations. Heat and mass transfer. Equipment in commercially important food processing applications. Raw food materials and packaging. Processing methods to ensure food safety and quality.
Prerequisite(s): BIOL 2604 and BIOL 2614 and (MATH 1025 or MATH 1524)
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4314 - Food Processing Laboratory (1 credit)
Safety and good manufacturing practice of food processing. Operation of key equipment found in the food industry. Collection, analysis and interpretation of data acquired in lab exercises. Documentation and reporting of findings.
Corequisite(s): 4304 or BSE 4604.
Instructional Contact Hours: (1 Lab, 1 Crd)

FST 4414 - Fermentation Process Technology and Instrumentation (2 credits)
Process design considerations for food and beverage fermentations, and other industrial fermentation processes. Critical process parameters, and instrumentation for fermentation process monitoring. Hands-on process instrumentation for fermentation.
Prerequisite(s): FST 4504 or FST 3604
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

FST 4504 - Food Chemistry (3 credits)
Overview of the chemical and functional properties of food components including major (water, proteins, carbohydrates, enzymes and lipids) and minor (vitamins, minerals, flavors, pigments) constituents; chemical, biochemical reactions and physical phenomena occuring during food handling, processing, and storage; their impact on the nutritional and sensorial quality of food.
Prerequisite(s): BCHM 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4524 - Food Safety and Quality Assurance (3 credits)
Monitoring safety and quality of food as well as compliance with government regulations. Description of regulatory agencies and food regulations. Development of specifications, food standards and safety critical control points. Systems to assure a safe and quality product, including acceptance sampling and statistical process control.
Prerequisite(s): FST 3604 and FST 4304
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4534 - Food Chemistry Lab (1 credit)
Investigation of functional properties of proteins, carbohydrates, and lipids in processed foods including effect of environmental conditions; solubility, foaming ability and textural properties of proteins, carbohydrate crystallization, ability of polysaccharides to form gels and pastes, lipid absorption and tenderization, characterization of a natural-occurring enzyme.
Corequisite(s): FST 4504
Instructional Contact Hours: (3 Lab, 1 Crd)

FST 4544 - Distillation and Fermentation Analysis (3 credits)
Sampling and analysis of pre-and post-fermentation foods and beverages to determine process termination, efficiency, and formation of desired and non-desired products. Laws and regulations pertaining to fermented foods and beverages. Distillation as an analytical tool and as a production method for food/beverage products.
Prerequisite(s): FST 4504 and FST 3514
Corequisite(s): FST 4104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FST 4634 - Epidemiology Foodborne Disease (3 credits)
Overview of causes, transmission, and epidemiology of major environmental, food, and water borne diseases. Outbreak and sporadic detection, source tracking and control of pathogens. Overview of the impact of foodborne outbreaks on regulatory activities at the national and international level. Corequisite: Enrollment in either FST 3604 or BIOL 4674.
Corequisite(s): BIOL 4674, FST 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4644 - Fermentation Microbiology (2 credits)
Physiology, biochemistry, and genetics of microorganisms used for production of food ingredients, fermented foods, and beverages. How microorganisms are used in fermentation and the effects of processing and manufacturing conditions on production of fermented foods.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 2 Crd)

FST 4654 - Food and Beverage Fermentation (2 credits)
Introduction to the broad range of fermented foods and beverages. Defining quality parameters of fermented foods and beverages. In-depth examination of the processing methods and equipment employed in commercial-scale production of fermented foods and beverages. Historical, cultural, sensory, and nutritional attributes of fermented foods and beverages. Course requirements may be satisfied by taking FST 3604 or FST 4504 prior to or concurrent with course.
Prerequisite(s): FST 4504 or FST 3604
Corequisite(s): FST 4644
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

FST 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Foreign Language (FL)

FL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2774 - Multilingualism and Language Contact (3 credits)
Exploration of multilingualism as a social and linguistic phenomenon. Examination of language practices in multilingual contexts around the world. Analysis of current socio-political policies pertaining to language in situations of language contact. Discussion of linguistic rights, such as economic opportunities, education, and national languages, and their connection to world affairs. Exploration of language revitalization efforts for endangered languages. Taught in English.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Forest Resources & Eviron Conservation (FREC)

FREC 1004 - Digital Planet (3 credits)
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 1084

FREC 1044 - Introduction to Environmental Data Science (3 credits)
Application of data science to environmental management. Role of data science, mathematical and statistical modeling, geospatial technology, database management, knowledge integration, and decision science in environmental decision-making. Skills and techniques required to assist scientists and managers with the challenges of collecting, collating, archiving, modeling, analyzing, visualizing, and communicating data in support of natural resource management.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2004 - Forest Ecosystems (3 credits)
Introduction to forest ecosystem ecology. Global forest cover, types, distribution, and change. Relationships among forest structure, function, and biodiversity. Interactions among rock, soil, water, air, and the organisms that define and inhabit forests around the world. Energy, water, carbon, and nutrient fluxes from leaf to global scales. Connections among forests, society, and global change. Capacity of forests to sustainably provide ecosystem services.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2114 - Ecology of Appalachian Forests (3 credits)
Introduction to the natural history, tree biology, tree identification, forest ecology, management and forest types of the Appalachian region. Contemporary issues related to forest functions will be discussed including carbon storage, climate change, invasive forest species, wildlife management, fire, biofuels, agroforestry, urban forests, ecosystem restoration, clean water, recreation, and use of renewable resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2124 - Forests, Society & Climate (3 credits)
Role of forest ecosystems on the global carbon cycle, climate, biodiversity and economies. Anthropogenic impacts on forest ecosystems and their ecological function in the face of changing climate. Regional and cultural implications for the state of the forests and deforestation-related policy. Climate-related threats to global forests, including loss of biodiversity, deforestation, forest fires, and invasive species. Sustainable forest management for anticipated future scenarios.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2134 - Plants and Greenspaces in Urban Communities (3 credits)
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 2134

FREC 2214 - Introduction to Land and Field Measurements (3 credits)
Measurement of land and field attributes including geographic position, land distance, direction, area, slope, elevation and boundary attributes. Use and development of maps used in natural resource applications. Use of global positioning systems and geographic information systems in the acquisition and management of land and field measurements. Assessment of vegetation attributes with field plots. Use of computer software to manage and analyze data and present results.
Prerequisite(s): MATH 1025 or MATH 1225 or MATH 1524
Corequisite(s): FREC 2324
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 2254 - Arboriculture Field Skills (1 credit)
Field observation, discussion, and practice of skills employed in the management of urban landscape trees. Hands-on experience with tree pruning, removal, pest control, fertilization, cabling/bracing, lightning protection, and climbing. Emphasis on arborist safety, professional ethics, and best management practices. Guest instruction provided in part by professionals working in the tree care industry.
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 2314 - Forest Biology and Dendrology (2 credits)
Introduction to the botany, physiology, genetics and silvics of important forest trees of North America.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (2 Lec, 2 Crd)

FREC 2324 - Dendrology Laboratory (1 credit)
Field identification of trees of North America with particular emphasis on trees native to the Eastern United States.
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 2414 - Field Experience in Forest Resources and Environmental Conservation (2 credits)
Field exercises to develop skills needed to sustainably manage forest and environmental resources including navigation and mapping, inventory of timber and non-timber resources, soil and water conservation, forest and recreation management, forest operations and timber harvesting. Fee $216.
Instructional Contact Hours: (6 Lab, 2 Crd)

FREC 2514 - Wildland Fire: Ecology and Management (3 credits)
Provide students with basic knowledge on how: fire has an impact on forest environments; the environment and weather influence fire behavior; wildland fires are suppressed; and fire is used as a land and vegetation management tool. The course will also provide students with the knowledge and training to qualify as a basic wildland firefighter (FFT2-Red Card). Extended laboratory sessions will provide practice in fire behavior prediction, prescribed burning techniques, and fire control methodology. COURSE FEE: $110.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 2554 - Leadership for Global Sustainability (3 credits)
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: LAR 2554, NR 2554

FREC 2614 - Human-Environment Systems (3 credits)
Social and ecological dynamics of human-environment systems. Effect of complex environmental problems on ecosystems and human well-being. Introduction to systems thinking. History, philosophy, and application of decision making in the field of natural resource management. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2784 - Global Forest Sustainability (3 credits)
A socio-economic approach to examining the management and use of the worlds forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 2784

FREC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 3044 - Environmental Data Science (3 credits)
Applications of the analysis and modeling of environmental datasets at multiple spatial-temporal scales to study environmental issues of societal importance. Computer programing is used in the acquisition, analysis, visualization, and storage of environmental data. Modeling techniques include regression, classification, and numerical simulation. Ethics and methods of data curation, quality control, analysis, and sharing.
Prerequisite(s): FREC 1044 or CMDA 2014 or CMDA 3654 or CS 3654 or STAT 3654
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3104 - Principles of Watershed Hydrology (3 credits)
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earths surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing
Prerequisite(s): MATH 1026 or MATH 1226 or STAT 3005 or STAT 3604 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 3104

FREC 3214 - Forest Biometrics (3 credits)
Statistical and mathematical basis for collecting and analyzing data used to make valid inferences and ethical decisions in applications of forest ecosystem science and management. Principles and practices of forest inventory and probability-based sampling. Computational and mathematical tools for analyzing field data. Statistical summarization, estimation, hypothesis testing, and inference from data collected in forest inventories.
Prerequisite(s): FREC 2214 and (MATH 1026 or MATH 1226)
Corequisite(s): FREC 3224
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3224 - Forest Measurements Field Laboratory (1 credit)
Field practice and computer analysis for collecting and analyzing survey data for use in forest management. Forest inventory and probability-based sampling, stratified sampling, double sampling, regression, and census-based sampling applications. Computer and geospatial tools for analyzing field data. Field assessment of tree and log contents, stand density, and site index. Collection and analysis of growth and yield data.
Prerequisite(s): (FREC 2214 or FOR 2214) and (FREC 2414 or FOR 2414)
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 3314 - Forest Ecology and Silvics (3 credits)
Environmental factors affecting the establishment, growth, and development of forests; silvical characteristics of trees; forest community structure and function; forest ecosystem analysis. COURSE FEE: $48.
Prerequisite(s): (FREC 2314 or FOR 2314) and (FREC 2214 or FOR 2214)
Instructional Contact Hours: (2 Lec, 4 Lab, 3 Crd)

FREC 3324 - Silviculture Principles and Applications (4 credits)
Theory and practices involved in controlling forest establishment, composition, and growth are developed in a regional context. Formulation of silvicultural systems and the study of reproduction methods, site preparation, intermediate stand manipulations, and reforestation operations.
Prerequisite(s): FREC 3314 or FOR 3314
Instructional Contact Hours: (3 Lec, 4 Lab, 4 Crd)

FREC 3354 - Trees in the Built Environment (3 credits)
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment.
Prerequisite(s): (FREC 2314 or BIOL 2304 or HORT 2304) and (FREC 2324 or HORT 3325 or HORT 3326)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 3354

FREC 3364 - Environmental Silviculture (3 credits)
Science and design of sustainable management of forests to meet the needs of a globalized society. Historic and current intercultural and socio-economic factors influencing stakeholder objectives and the shape, value, pattern, composition, structure, and function of forests domestically and abroad. Tools used to design forests and management plans to address global challenges. Design thinking process: gather stakeholder input, brainstorm/analyze ideas, develop potential solutions, test their working hypothesis or prototype in a computer simulation, and iterate/improve toward a sustainable solution.
Prerequisite(s): FREC 2324
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3454 - Trees in the Built Environment Lab (1 credit)
Hands-on experience in the cultivation, conservation, and management of landscape trees in human-dominated environments along the urban to rural gradient. Field exercises in tree inventory, appraisal, disorder diagnosis, planting, pruning, and protection. Emphasis on use of scientific methods and best management practices to ensure tree health, safety, and functionality for the benefit of people and the environment. Methods of communicating technical information and management recommendations for landscape trees through written media.
Corequisite(s): FREC 3354
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 3524 - Environmental Interpretation (3 credits)
Interpretation theory and techniques as relevant to natural resource management; culturally appropriate program planning and evaluation; role of interpretation in enhancing visitor experiences and promoting stewardship. Pre: Junior standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3544 - Outdoor Recreation Planning and Management (3 credits)
Planning and management of nature-dependent outdoor recreation. History, philosophy and benefits of nature-dependent outdoor recreation. Environmental and social impacts of recreational uses. Techniques to manage visitor impact. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3574 - Environmental Education Service Learning (3 credits)
Introduction to key concepts in environmental education and teaching skills through lecture, discussion, service learning, and reflection. Training in internationally recognized environmental education curricula (e.g. Project Learning Tree, Project Wet), in class management and organization skills and in theory relevant to both teaching and learning. Students develop and conduct after school environmental education programs at local elementary schools
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3714 - Forest Harvesting (3 credits)
Principles and application of forest harvesting. Terminology, phases, function, and the interrelationships of people, money, machines, and environment. COURSE FEE: $60.
Prerequisite(s): FREC 2214 or FOR 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3724 - Forest Boundaries and Roads (3 credits)
Application of basic land surveying and forest measurement techniques to the location, establishment, and maintenance of forest boundaries and roads. Consideration of stream crossings, best management practices, and costs. Fee $187.
Prerequisite(s): FREC 2214 or FOR 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3734 - Forest Fiber Supply (3 credits)
Analysis of the southeastern U.S. forest industry fiber supply process with emphasis on the evolution and dynamics of timber procurement systems, strategies, business principles, ethical dilemmas, and professional practices. Field exercises and case studies to ethically appraise timber sales. Analysis of current industrial operations and practices. Discourse-based project resulting in the writing, presenting, and critiquing of procurement plans. Pre: Junior standing. COURSE FEE: $365
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3754 - Watersheds and Water Quality Monitoring (3 credits)
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems.
Prerequisite(s): (BIOL 1106 or BIOL 1006) and CHEM 1035 and (FREC 2004 or FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 3754

FREC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 3964 - Internship Through Directed Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

FREC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4004 - Professional Skills in Natural Resources (1 credit)
Elements of professionalism and principles of success across a wide spectrum of natural resources careers. Skills for ethical and professional interaction including effective communication, advancement of diversity and inclusion, and personal responsibility. Career preparation principles including employer outreach, job seeking, resume writing, and interview preparation. Guest speakers from academia, industry, and government. Pre: Senior standing.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: NR 4004

FREC 4014 - Natural Resources Economics (3 credits)
Examination of domestic and international natural resource use, exploitation, and degradation problems, with special focus on use of economics to understand why potential overuse of natural resources exists, and what policy options are available to correct these problems and ensure sustainable natural resource use over time. Water, forests, fisheries, land and exhaustible resources. Permission of instructor may be substituted for the pre-requisite.
Prerequisite(s): ECON 2005 or AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 4014

FREC 4024 - Forest Resources Management and Business (3 credits)
Forest management and business principles, theory, and methods to support sound decision-making in forestry: from the level of the forest to the business organization as a whole. Capital budgeting methods to prescribe forest harvest schedules and perform forest finance analyses. Forest industry structure, trends, and future performance. Strategic management frameworks (e.g. SWOT (Strengths, Weaknesses, Opportunities, and Threats), PIE (Potential, Importance and Ease) and Porter's Five Forces) and the influence of public policy and regulation on forest business strategy. Ethics, sustainability and corporate social responsibility applied to real forest business problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4044 - Environmental Data Science Capstone (3 credits)
Apply environmental data science strategies and techniques to natural resources problems. Capstone experience using spatial and/or temporal environmental data. Integrate multiple concepts and strategies to create a practical solution.
Prerequisite(s): FREC 3004 or FREC 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4114 - Information Technologies for Natural Resource Management (3 credits)
An introduction to computer information systems used in natural resources management. Course will introduce students to the theory and applications of database management systems (DBMS) and geographic information systems (GIS). Uses, challenges, and limitations of these technologies in natural resource management applications will be discussed. Students will receive extensive hand-on instruction in the use of current software packages for DBMS and GIS.
Prerequisite(s): FREC 2214 or FOR 2214 or GEOG 2314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4134 - Forest Carbon Management and Policy (3 credits)
Importance of forests in the global carbon cycle. Measuring, reporting, and verification (MRV) of forest carbon stocks and fluxes. National, regional and international forest carbon markets. Main national and international forest-based carbon policies and programs, such as REDD +. Impacts of forest management practices by landowners and policies on forest carbon stocks. Economic viability of forest carbon projects. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4174, PSCI 4174

FREC 4214 - Forest Photogrammetry and Spatial Data Processing (3 credits)
Films, filters and camera photogeometry; scale; measurement estimation; image processing; flight planning and photo acquisition; geographic information systems; spatial data analysis techniques and applications. Pre: Junior standing.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4244 - Hydroinformatics (3 credits)
Analysis and examination of hydrologic data using basic statistics and computer programming. Calculation and interpretation of flow frequency and duration, hydrologic analysis of geospatial digital terrain data, and implementation and analysis of simple hydrologic models. Advanced methods of temporal and spatial hydrologic data visualization using computer programming.
Prerequisite(s): FREC 3104 or WATR 3104 or FREC 1044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 4244

FREC 4324 - Genetics of Natural and Managed Populations (3 credits)
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology.
Prerequisite(s): BIOL 1105 and BIOL 1106 and (STAT 3005 or STAT 3615 or FREC 3214 or FOR 3214)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FIW 4324

FREC 4334 - Principles and Practice of Agroforestry (3 credits)
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects. COURSE FEE: $40.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 4334

FREC 4354 - Forest Soil and Watershed Management (3 credits)
Properties and processes of soil and water in forests. Emphasis on management for the delivery of ecosystem services at local to global scales. Includes analysis and interpretation in field and laboratory.
Prerequisite(s): CSES 3114 or FREC 2004 or GEOS 3614 or ENSC 3134
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4364 - Advanced Silviculture and Forest Vegetation Management (3 credits)
Advanced topics in silviculture with an emphasis on species silvical differences; forest vegetation management and control, herbicides used in forestry, their chemistry, toxicology, application technology; environmental considerations; tree improvement, individual tree growth, and stand dynamics as affected by intermediate silvicultural operations; implications of atmospheric deposition.
Prerequisite(s): FREC 3324 or FOR 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4374 - Forested Wetlands (3 credits)
Classifications, jurisdictional delineation, and management options of forested wetlands. Relationship of hydrology, soils, and vegetation to ecosystem processes, societal values, and management with regard to environmental and legal considerations and best management practices. Emphasis is on forested wetlands in the southern U.S., but national and international wetlands are included. COURSE FEE: $187.
Prerequisite(s): FREC 4354 or CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4414 - Advanced Wildland Fire Management (3 credits)
Impacts fire has on forest environments; how the environment influences fire behavior; how computer programs aid fire decision making; and how fire is used as a land and vegetation management tool. Influences of weather on fire behavior. The course will also provide students with the knowledge and training to qualify as an advanced wildland firefighter (Squad Boss) (FFT1 - Red Card) and a Virginia Certified Prescribed Burn Manager.
Prerequisite(s): FREC 2514 or FOR 2514
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4424 - Forest Resources Economics and Management (3 credits)
Application of economics principles and tools to forest decision making from the individual tract to large private and public holdings. Private and public landowner financial incentives and decisions, forest amenities, non-timber forest products, risk, multiple use, management and ownership trends, and sustainability are examined. Prerequisite course or consent of instructor.
Prerequisite(s): FREC 3324 or FOR 3324 or FREC 3364 or FOR 3364
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4434 - Natural Resource Policy (3 credits)
Historical development of U.S. natural resource policy. Application of policy analysis tools to understand the factors driving natural resource policy formation at the federal, state, and local level. Evaluation of the effects of alternative policies on natural resource use and social wellbeing. Overview of existing natural resource policies with applications to forest and timber management, biodiversity, public lands, endangered species, and climate change mitigation and adaptation.
Prerequisite(s): NR 4014 or FREC 4424 or FOR 4424 or ECON 4014 or FREC 4014 or FOR 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4444 - Integrated Forest Management Practicum (3 credits)
Application of accumulated discipline-oriented knowledge and techniques to solve forest resource management problems as a member of a team. Forest resource management and planning, multiple-use concepts to solve forest management problems, design and implement field-based sampling protocol, develop an integrated forest management plan with logical and ethical recommendations based on analysis of sampled data. Pre: Senior standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FREC 4454 - Urban and Community Forestry (3 credits)
Ecological, socioeconomic, and technical aspects of assessing, planning, managing, and conserving urban forests. Examination of historical and contemporary approaches to urban forestry in local, national, and international contexts. Contributions of trees and associated greenspaces to urban sustainability and community well-being. Roles of government, private industry, and community stakeholders in stewarding urban forests. Theory and practice of written and oral communication to effectively exchange ideas and information about urban forests with diverse audiences. Pre: Junior standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4464, WATR 4464

FREC 4514 - Forest and Tree Pest Management (3 credits)
Identification and ecology of biotic and abiotic influences on forest and landscape tree health. Developing a theoretical and practical understanding for diagnosing and managing pests and stresses of trees in both the forest and landscape setting. Insects and diseases that attack trees.
Prerequisite(s): FREC 3324 or FOR 3324 or HORT 3325 or HORT 3326
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, HORT 4554, LAR 4554, SPIA 4554

FREC 4714 - Harvesting Systems Evaluation (3 credits)
Principles and techniques for evaluating harvesting machines and systems design, application, productivity, and financial performance.
Prerequisite(s): FREC 3714
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4784 - Wetland Hydrology and Biogeochemistry (3 credits)
Water flows creating wetland hydrologic regime. Hydrologic controls on wetland processes. Linkages between hydrology and biogeochemical cycles. Carbon, nitrogen, phosphorus, and other element cycles within and across wetland boundaries. Field methods to assess hydrologic regime and biogeochemical cycles. Ecosystems services from hydrologic and biogeochemical processes. Applications of wetland hydrology and biogeochemistry in wetland restoration, delineation, and creation.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Free Elective (VT)

VT 1XX5F - GEN ED QUANT/COMP THINK FOUND (3 credits)
Pathway Concept Area(s): 5F Quant & Comp Thnk Found.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

French (FR)

FR 1105 - Elementary French (3 credits)
Fundamentals of the French language with emphasis on grammar, reading, composition, and conversation. 1105 for students with no prior knowledge of the language; 1106 for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 1106 - Elementary French (3 credits)
Fundamentals of the French language with emphasis on grammar, reading, composition, and conversation. 1105 for students with no prior knowledge of the language; 1106 for students who have completed 1105 or less than three years in high school.
Prerequisite(s): FR 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 1114 - Accelerated Elementary French (6 credits)
Proficiency-oriented approach to Elementary French, designed for learners who wish to progress rapidly through the beginning stages of language learning. Development of the four language skills (speaking, listening, reading, writing) and basic cultural competency through the study of authentic materials. Duplicates FR 1105 and FR 1106. Taught in French.
Instructional Contact Hours: (6 Lec, 6 Crd)

FR 2105 - Intermediate French (3 credits)
Emphasizes comprehension of written and spoken French, communication in French, literature, and culture of French-speaking world.
Prerequisite(s): FR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2106 - Intermediate French (3 credits)
Emphasizes comprehension of written and spoken French, communication in French, literature, and culture of French-speaking world.
Prerequisite(s): FR 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2114 - Accelerated Intermediate French (6 credits)
Proficiency-oriented approach to intermediate French, designed for learners who wish to progress rapidly through the intermediate stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context using authentic materials. Taught in French. Accelerated version of 2105-2106. Duplicates 2105-2106.
Prerequisite(s): FR 1106 or FR 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

FR 2164 - Intermediate Business French (3 credits)
This course emphasizes all four language skills (reading, writing, speaking, and listening) by focusing on various facets of the world of business and technology. It also develops students understanding of French institutions and business practices.
Prerequisite(s): FR 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2714 - Introduction to French Culture and Civilization (3 credits)
French culture and civilization from prehistoric cave paintings to the present. Interdisciplinary approach to literature, film, art, achitecture, intellectual movements, and lifestyle in the context of French political history, society, and globalization, including elements of French culture that arrived through conquerors, migrants, and immigrants. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

FR 2794H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

FR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 3105 - Composition, Conversation and Grammar (3 credits)
Development of the ability to write and speak through the effective use of French syntax and morphology. Increased reading and listening skills through the study of authentic materials in the target language. Understanding the role of culture in communication. Conducted in French.
Prerequisite(s): FR 2106 or FR 2164
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3106 - Composition, Conversation and Grammar (3 credits)
Development of the ability to write and speak through the effective use of French syntax and morphology. Increased reading and listening skills through the study of authentic materials in the target language. Understanding the role of culture in communication. Conducted in French.
Prerequisite(s): FR 2106 or FR 2164
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3125 - French for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken French. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S -1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the ACTFL-OPI or a 2 on the FSI scale. Admission by oral exam.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3126 - French for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken French. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S -1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the ACTFL-OPI or a 2 on the FSI scale. Admission by oral exam.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3154 - French for the Natural Sciences (3 credits)
Knowledge of the French language and its cultures to the natural sciences. Study of scientific materials in French. Practice in communication skills through contextualized use of specific vocabulary, idiomatic expressions, grammar structures and cultural practices in real-world situations. Discussion on scientific topics and debates of the French-speaking world. Comparison of the practices and world views of scientists and clinicians in French and English-speaking countries. Taught in French.
Prerequisite(s): FR 3106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3164 - Advanced Business French (3 credits)
In this skills-based course, students learn to use appropriate French technical vocabulary for different business contexts, do translation, write professional correspondence, and read articles related to the worlds of business, economics, and finance. Cross-cultural differences regarding the work place are also a focus of the course.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3304 - Introduction to French Literature (3 credits)
Introduction to French literature through analysis and discussion of selected texts from different periods and genres. Methods, terminology, and practice of literary analysis. Intensive writing component.
Prerequisite(s): FR 3105 or FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3314 - Introduction to Francophone Studies (3 credits)
Introduction to the literatures and cultures of French-speaking regions outside of France including North Africa, the Caribbean, Sub-Saharan Africa, and Quebec. Examination of thematic and cultural aspects of literatures of those regions within their socio-historical contexts. Exploration of movements and notions as Negritude, postcolonialism, identity, race, and nation as they relate to the legacy of colonial France. Development of research skills such as finding appropriate sources and proper citation, and of intercultural sensitivity through analysis of works outside Western traditions. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3424 - French Culture from Middle Ages to Renaissance (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from the Middle Aes to the end of the Renaissance. Emphasis on nation-building and cultural production. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts affects from a chronological and thematic perspective. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3434 - French Culture from Baroque to Revolution (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from the Baroque era to the French Revolution (1610-1799). Emphasis on nation-building and cultural production in a European and Global context. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts from a chronological and thematic perspective. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3444 - French Culture from Romanticism to Belle Epoque (3 credits)
Overview of major events, movements, ideas, works, and figures in French culture from the Romantic period (1800) through the Belle Epoque (1914). Emphasis on literary and cultural works in their social and historical contexts. Critical reading and analysis in French. Study of the impact of French history on French culture. Interpretation of intercultural experiences according to different world views. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3454 - French Culture from World Wars to Global Present (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from World War I to the present, a period characterized by colonialism, world conflict, and globalization. Analysis of literary and cultural works in their social and historical contexts, toward an understanding of the French language as a global idiom involving diverse worldviews and cultures. Critical reading and writing in French. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4154 - Advanced Composition and Stylistics (3 credits)
Intensive work in written French. Development of the students ability to write clear, correct, and articulate French in a variety of modes (e.g., epistolary style, the formal and informal essay). Writing intensive.
Prerequisite(s): FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 4164 - Special Topics in Business French (3 credits)
A variable content course devoted to developing and perfecting highly advanced language skills through the study of special topics in the French and francophone business worlds. Emphasis on a mastery of specialized French for professional settings. May be repeated for credit with different content. Taught even years.
Prerequisite(s): FR 3106 and FR 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 998.99 credit hours

FR 4314 - Studies in French Literature (3 credits)
In-depth study of a selected topic in French literature, such as an author, a group of authors, a literary movement or genre during a specific period of French literary history (i.e., Voltaire, the Pleiade, Romanticism, the nouveau roman). May be repeated for credit with different content.
Prerequisite(s): FR 3304 and (FR 3314 or FR 3424 or FR 3434 or FR 3444 or FR 3454)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

FR 4324 - Special Topics in French Life, Literature and Language (3 credits)
In-depth study of a selected topic in French culture or language as manifested in creative and historical literature, music, art, film, etc., such as phonetics, translation techniques, or the staging of dramatic works in French. May be repeated for credit with different content.
Prerequisite(s): FR 3304 and (FR 3314 or FR 3424 or FR 3434 or FR 3444 or FR 3454)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

FR 4794 - Senior Tutorial in French Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level French course, senior standing, French major, and consent of French Section required.
Instructional Contact Hours: (1 Lec, 1 Crd)

FR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Geography (GEOG)

GEOG 1004 - Introduction to Human Geography (3 credits)
Introduction to geography as a social science. Development of a conceptual framework for studying and evaluating human-environment relationships. Through examination of selected regional and global issues and through exploring basic concepts like regions, place, location, human-environment interaction, movement, and accessibility, students will discover how power is spatially expressed and explore how culture shapes the production of space and vice versa. Students will also discover and describe how ethical issues manifest spatially.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1014 - World Regions (3 credits)
Human and physical patterns and characteristics of major regions of the world including political systems, religions, economies, and physical settings. Concepts and perspectives of geography as a social science; linkages and interdependence of nations and regions; analysis of media coverage of events or global issues; engagement with current and historical global affairs.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1024 - Survey of Geography (1 credit)
Foundations of geography and subdisciplines. Career pathways for geography-interested students in various workforce sectors and sub-disciplinary specialization areas, including physical geography, GIScience, and human geography. Introduction to campus academic and geography-related career resources to enhance the undergraduate experience. Professional goal reflection and development.
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 1084 - Digital Planet (3 credits)
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 1004

GEOG 1104 - Introduction to Physical Geography (3 credits)
Integrated study of major subsystems of the natural environment: the nature, distribution, and interrelationships of landforms, climate and vegetation.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1115 - Seeking Sustainability (3 credits)
1115: Strategies to promote sustainability through the identification, description, and analysis of the dominant interconnections within and between environmental, social, and economic systems across local to global scales. 1116: Perceptions of, conditions of, and strategies to analyze processes of change within complex systems, and promote sustainability across local to global scales.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 1115

GEOG 1116 - Seeking Sustainability (3 credits)
Prerequisite(s): GEOG 1115 or NR 1115
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 1116

GEOG 1504 - Survey of Meteorology (1 credit)
An introductory look into the world of meteorology, including the role of forecasters, broadcast meteorologists, current research, and the prediction and response to significant storm events.
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 1514 - Introduction to Meteorology (3 credits)
Foundational properties and processes of Earth's atmosphere. Governing radiative and thermodynamic atmospheric equations. Extratropical weather systems, thunderstorms, hurricanes, and tornadoes. Cultural and societal impacts of extreme weather and climate change. Using meteorological and atmospheric data to construct weather forecasts.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1524 - Introduction to Earths Climate (3 credits)
An introduction to Earths climate system, including the physical mechanisms responsible for the global climate as well as its spatial and temporal variation; composition and structure of the atmosphere, radiation budget and temperature, precipitation and hydrologic budget, atmosphere and oceanic circulation, weather systems, paleoclimate, future climate; synergistic human-climate relationships, including global warming, climate change.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2004 - Water, Environment, and Society (3 credits)
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 2004

GEOG 2014 - Health and Place: Introduction to Health Geography (3 credits)
A survey of the field of health and medical geography. A study of the underlying interconnected processes at global to local scales from ecological and social perspectives that explain geographic patterns related to health, disease, and access to healthcare. Analysis of spatial patterns depicted on maps and connection to explanatory processes related to environmental exposures, demographic change, and the intersection of power, culture, and identity. Development of health-related written and oral content for broad audiences. Assessment and critique of presentation of scientific findings in popular media.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2034, PSCI 2034

GEOG 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2054, PSCI 2054

GEOG 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2064, PSCI 2064

GEOG 2074 - COVID-19: Global Pandemic, Local Impacts (3 credits)
Examination and analysis of COVID-19's diffusion through the population at multiple spatial scales, from global to individual, using theories and methods of social science and medical geography. Critical study of the pandemic as a biological and social phenomenon, place within its cultural, historical, economic, political, and geographic contexts. Development of persuasive logical arguments on COVID-related topics through analyzing country, US state, and local level impacts of the COVID pandemic. Critical analysis of responses to the COVID pandemic. Synthesis of interconnected variables that contribute to differential impacts of COVID on different population groups. Identification of factors that may contribute to future pandemics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2084 - Principles of Geographic Information Systems (3 credits)
Principles and diverse applications of Geographic Information Systems, geographic coordinate systems, Cartesian map projections, spatial data sources, GIS databases, map representations, and illustrated spatial applications of GIS. Requires regular use of computer systems for geographic data analysis.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2104 - Introduction to Environmental Security (3 credits)
Environmental security concepts, issues, and terminology. Study of emerging issues at the nexus of environmental and climate change and security risks, including homeland, human, national, energy, food, and water securities. Overview of climate-driven conflicts, displacement and migration, and geopolitical instability. Policy and programmatic solutions. Assessment of case studies using methods such as strategy analysis, scenario development, and simulations.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2114 - Introduction to Coastal Regions (3 credits)
Introduction to coastal geomorphology (landforms and processes), climate drivers (sea level rise and storms surge), and natural systems that shape coastal regions. Study of human systems including population growth, built environment, and social vulnerability. Overview of coastal zone management and policy. Discussion of the future of coastlines shaped by complexity, emerging challenges, uncertainty, adaptation, and resilience.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2134 - Geography of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2134, PSCI 2134

GEOG 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2224, PSCI 2224

GEOG 2244 - Sustainable Urbanization (3 credits)
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. Fee $30.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 2244

GEOG 2314 - Maps and Mapping (3 credits)
Introduction to maps. Fundamentals of reading, analysis, and interpretation of hard copy and digital maps, as they are required to illuminate spatial problems. Influences of maps on attitudes toward and images of the geographic environment.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2505 - Weather Analysis I (3 credits)
Introduction to the operational tools and processes in weather forecasting. Surface data and upper-air sounding analysis, forces producing and directing wind flow, jetstreams, weather chart analysis, and atmospheric moisture including clouds and precipitation.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2506 - Weather Analysis II (3 credits)
Introduction to the operational tools and processes in weather forecasting. Numerical forecast modeling and current operational models, ensemble forecasting and model output statistics, structureand dynamics of fronts and mid-latitude cyclones, development of thunderstorms and tornadoes, and the use of Doppler radar and satellite imagery in short-term forecasting.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2784 - Geography of Tea (3 credits)
Physical and human geographic overview of tea. Biogeography, history, economics, and ceremonial practices of the worlds tea producing regions. Analysis of terroir and processing through tasting exercises and sensory evaluation. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3034, PSCI 3034

GEOG 3104 - Environmental Problems, Population, and Development (3 credits)
Environmental problems in their social, spatial, and global contexts. Impacts of globalization, neoliberalism, and population growth on the environment. Examination of effects of developed and developing countries on the environment. Focus on conceptualizing development, population dynamics, environmental justice, factory farming, energy and renewable energy, global health, disasters, and intercultural and global awareness.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3214 - Africa Together (3 credits)
Strategies to identify, discuss and apply theories of stereotyping, empathy, and scarcity in the context of contemporary Africa. Application of theories to compare and analyze examples of social networks, music, disease, and violence in Africa and the U.S. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3224 - Geography of Appalachia (3 credits)
Appalachia as a region: physical environment, development of internal settlement, cultural, and economic patterns. Human adaptations to environmental change, traditions, and connections to and from external regions.
Prerequisite(s): GEOG 1004 or GEOG 1104 or GEOG 1014 or APS 1704 or HUM 1704
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3234 - Geography of Virginia (3 credits)
Virginia as a region: its physical environment, settlement, cultural, economic, and political patterns. Human adaptation to environmental change, human modification of environments and linkages to external regions. Climate, Biogeography and Water, and Environmental Hazards related to Natural Resources. Pre: 3 credit hours of Geography.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3244 - The U.S. City (3 credits)
The economic, political, and social forces driving urbanization in the United States. The American city in historical context with particular emphasis on the rise of manufacturing, deindustrialization, and suburbanization. Case studies from the manufacturing and sunbelt regions to illuminate key constructs from urban and human geography. Border examples of comparative urbanization from the U.S. -Mexican border, the Caribbean, and Canada.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3254 - Geography of East Asia (3 credits)
A geographical analysis of several modern states in East Asia, specifically China, Japan and the Koreas. Economic, political, and cultural change since the end of World War II. Globalization and the emergence of the China as a demographic and economic giant.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3274 - Polar Environments (3 credits)
Introduction to polar regions emphasizing interdisciplinary concepts, a systems approach, and communication of polar science to non-scientific audiences. Developing and defending arguments on the global significance and geopolitics of polar regions. Feedbacks among biophysical and human processes and resources. Strategies to deliver effective oral presentations, and to defend arguments in writing and group debates on topics including multiculturalism, human-environmental interactions, and climate change impacts in polar regions. Foster understanding of indigenous worldviews using native narratives. Pre: Sophomore standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3304, GEOS 3304

GEOG 3314 - Cartography (3 credits)
Science and art of cartography including the conceptual framework of the cartographic method. Development of the skills necessary to create maps to be used in the analysis of spatial phenomena. Emphasis on thematic and ethical cartography.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOG 3404 - Mountain Geography (3 credits)
Physical characteristics of mountains, such as steep slopes, climatic extremes, and sharp environmental gradients, and their influences on the ways in which people, animals, and plants interact. Physical processes that operate in high-relief environments, including consideration of climate, geomorphology and biogeography. Influence of physical processes in mountain environments on human culture and activities. Cultural significance of mountains. Mountains as a resource. Land use and human-land interactions in mountains. Course is intended for students with an interest in what makes mountains unique and inspiring landscape elements.
Prerequisite(s): GEOG 1104
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

GEOG 3504 - Severe Weather (3 credits)
An introduction into mesoscale environments favoring the development of severe thunderstorms and tornadoes, the analysis of moisture, instability and shear parameters associated with severe weather events. Thunderstorm life-cycles, analysis of thermodynamic diagrams, role of wind shear and associated convective mode, hail production and forecasting, tornadogenesis and research.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3515 - Dynamic Meteorology (3 credits)
Examination of the physics that govern motion of Earths atmosphere. General atmospheric concepts, atmospheric principles of thermodynamics, hydrostatics, and stability. 3516: Examination of the physics that govern motion of Earths atmosphere. Principles of fluid dynamics, specifically the physics governing horizontal motion, corresponding vertical motions, and synoptic scale systems, as represented in various coordinate systems.
Prerequisite(s): GEOG 2506 and MATH 2214 and (PHYS 2206 and PHYS 2216 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3516 - Dynamic Meteorology (3 credits)
3515: Examination of the physics that govern motion of Earths atmosphere. General atmospheric concepts, atmospheric principles of thermodynamics, hydrostatics, and stability. 3516: Examination of the physics that govern motion of Earths atmosphere. Principles of fluid dynamics, specifically the physics governing horizontal motion, corresponding vertical motions, and synoptic scale systems, as represented in various coordinate systems.
Prerequisite(s): GEOG 3515
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3844, PSCI 3844

GEOG 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

GEOG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 18 credit hours

GEOG 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4044 - Biogeography (3 credits)
A survey of the field of biogeography. A study of the factors influencing the distribution of plants and animals approached from ecological, historical, and cultural perspectives. Human influence on biotic patterns, such as crop domestication, habitat alteration, species introductions and extinctions, management issues, and environmental change, is a primary focus.
Prerequisite(s): GEOG 1104 or BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4054 - Geography of Wine (3 credits)
Analysis of physical and cultural forces that shape the production, consumption, and great variety of wine in the world. Wine as a complex commodity is examined through its economic, social, political, and ideological impacts in different parts of the world throughout history. Particular emphasis will be focused on place as an agent in defining the product.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4074 - Medical Geography of Infectious Diseases (3 credits)
Examination of geographic patterns of infectious diseases and underlying explanatory processes at spatial scales ranging from global to local. Interactions between natural and social environments and their contributions to infectious disease burdens. Human health impacts of climate variability and change. Application of theories such as landscape epidemiology and methods in medical geography and the social sciences to understanding disease emergence events and pandemics. Examination of role of environmental change and human migration on disease diffusion patterns. Analysis of major factors related to HIV/AIDS epidemic that explain the disease's spatial and spatio-temporal pattern in different social and cultural settings. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4084 - Modeling with Geographic Information Systems (3 credits)
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Course Crosslist: GEOS 4084

GEOG 4094 - Generative AI Applications in Social Science (3 credits)
Apply key concepts in generative AI to social science research across multiple disciplines, including geography, urban studies and planning, environmental studies, education, writing, sociology, psychology, political science, and economics. Analyze quantitative and qualitative data by utilizing various generative AI tools, such as ChatGPT and Dall-E. Integrate the geographic information system (GIS) with generative AI tools. Evaluate the impacts of generative AI on society in terms of ethical concerns, geographic and sociodemographic biases, and responsible uses. Criticize existing generative AI tools. Develop public and educational policies to guide the responsible use of generative AI for social science research. Pre: Junior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4134 - Interdisciplinary Issues and Ethics in Water Resources (3 credits)
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOS 4134

GEOG 4164 - Qualitative Methods & Ethics in Geography (3 credits)
Overview of qualitative research methods in the context of human geography. Theories, practices, and interpretations surrounding human geography methods. Debates surrounding the use of a range of qualitative methods. Critical analysis of academic writing. Data collection, analysis and interpretation methods. Epistemological underpinnings of qualitative methodological choices. Ethical considerations related to human subject research. Visual, graphic, and oral communication skills. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4184 - Health Applications of Geospatial Techniques (3 credits)
Investigation of theoretical foundations and practical uses of geospatial techniques in the analysis of human health data. Emphasis on description of spatial data and measurement of clustering of diseases and health concerns. Quantification of exposure to pathogens and environmental factors that impact human health to explain clusters. Analysis of health disparities and their impact on health. Acquisition and analysis of health data, interpretation of findings, and presentation of results in independent analysis. Development of policies to promote population health.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4204 - Geography of Resources (3 credits)
Physical and cultural systems that influence the spatial distribution of resources and resource use. Emphasis on historical and current contexts of natural resources use and perspectives in the United States, with consideration of worldwide distributions of resources. Environmental cognition and perception, water, public lands, conservation and preservation, food and hunger, human population, and alternative energy. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4214 - Gender, Environment, and International Development (3 credits)
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4214, WGS 4214

GEOG 4224 - Tracking Environmental Change (3 credits)
Multidisciplinary approaches to documenting and understanding past environmental change. Methods used to unravel the physical and human drivers of historical and longer-term changes in climate, vegetation, and fire patterns. Application of environmental change data and insights to improve land and conservation management under changing climates. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4254 - R Programming for Geospatial Applications (3 credits)
Geospatial data analytics using R programming language. Batch-processing capability for analyzing large vector and raster geospatial data including remote sensing imagery and GIS layers. Using R scripts, algorithms, and functions to implement spatial analysis and spatial-temporal modeling. Bridging open source GIS/remote sensing and Machine learning. Linux system and high-performance computing environment.
Prerequisite(s): GEOG 4084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4284 - Human Dimensions of Coastal Social-Ecological Systems (3 credits)
Coastal change and multiple stressors. Social-ecological systems. Concepts of resilience, vulnerability and adaptation to climate change. The tragedy of the coastal commons. Adaptive management, co-management, adaptive co-management. Non-Western knowledge systems, Indigenous and local knowledge. Food security, blue food systems, food system transformations. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4304 - Geospatial Analysis of Mobility (3 credits)
Apply key concepts in human mobility and travel behavior theories to real-world scenarios. Analyze emerging issues in mobility and its impacts on society, encompassing topics such as ride-hailing services, autonomous vehicles, AI, and smart city technologies, and evaluate their implications for future urban development. Evaluate and implement R- and Python-based geospatial analysis tools to address contemporary mobility issues. Synthesize and analyze big geospatial and human mobility data. Propose innovative policy and urban planning recommendations.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4314 - Spatial Analysis in Geographic Information Systems (3 credits)
Theory and application of Geographic Information Systems, with special emphasis on analytical operations, database design, cartographic modeling, and raster GIS. Spatial data handling and analysis to facilitate decision-making through the communication of geographically referenced data.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOG 4324 - Algotrithms in Geographic Information Systems (4 credits)
Computational methods in automated mapping and map analysis. Visual Basic programming and algorithm design for spatial display and analysis under both raster and vector data models. Requires regular use of the departmental microcomputer and UNIX workstation laboratory.
Prerequisite(s): GEOG 4084 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOG 4334 - Geospatial Information Technology for Land Change Modeling (3 credits)
Analysis of the spatio-temporal patterns of Land Use and Land Cover Change (LULCC) as observed in satellite images. Tropical deforestation, urbanization, and agricultural intensification. Rates and patterns of LULCC linked to biophysical and socio-economic drivers. Impacts of land change with respect to local climate, biodiversity, water yield and quality, and ecosystem services.
Prerequisite(s): GEOG 4084 or GEOS 4084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4354 - Introduction to Remote Sensing (3 credits)
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar, and thermal infrared imagery. Digital analysis, image classification, and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOS 4354

GEOG 4374 - Remote Sensing and Phenology (3 credits)
Analysis of spatial and temporal patterns of the vegetated land surface as observed by satellite images. Application of satellite image time series to derivation of land surface phenology, and analysis of the appearance and development of phenology in the USA and worldwide. Methods of monitoring of phenology with satellite imagery. Causes of spatio-temporal changes of phenological events. Effects of global climate change.
Prerequisite(s): GEOG 4354
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4394 - Introduction to Web Mapping (3 credits)
Application of web mapping technologies to geographic data collection, storage, analysis, and display. History and context, spatial data infrastructures, hardware and software architectures, open geospatial consortium standards, mapping APIs, virtual globes, user-centric design, web cartography. Group and individual projects.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4404 - Geovisualization (3 credits)
Advanced topics in digital and dynamic map production, emphasizing concepts in advanced cartographic design, information visualization, and human-computer interaction. Topics include cartograms, computer aided design, animation, lidar and photogrammetric point cloud visualization, Web Geographic Information Systems, terrain visualization, and virtual geographic environments.
Prerequisite(s): GEOG 2084 and GEOG 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4414 - Climate Change and Societal Impacts (3 credits)
Impacts of climate change on different societies. Concepts of adaptation, vulnerability, and resilience. Notions of complexity, uncertainty, and thresholds related to climate change outcomes. Case study analysis of communities affected by climate change. Understanding future and assessing climate vulnerability across various spatiotemporal scales. Scenario planning, foresight analysis, and interactive digital tools. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4444 - Practicing Sustainability (3 credits)
Practicum in sustainability. Synthesize and integrate knowledge from undergraduate career and apply to real world problems of sustainability. Topics and projects selected from opportunities to examine specific local and regional sustainability issues on the VT campus, in the New River Valley and the Commonwealth at large. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 4444

GEOG 4504 - Synoptic Meteorology (3 credits)
Examination of large-scale (1000-5000km) weather systems using both analytical and operational analysis. Topics include thermal structure of atmosphere & resulting circulation, frontal analysis, lifting mechanisms, barotropic/baroclinic systems, and mid-latitude cyclones. Weather pattern influences of the jetstreams and oscillation of large pressure systems including El Nino/La Nina and the North Atlantic Oscillation.
Prerequisite(s): GEOG 3504 and MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4514 - Tropical Meteorology (3 credits)
Tropical weather and climate topics: remote sensing and observations; tropical climatology, including regional and large-scale circulations, monsoons, and the El Nino/Southern Oscillation; tropical convection, including the clouds in the subtropics, deep convection in the equatorial region, and tropical cloud clusters and thunderstorms; and tropical cyclones, including their structure, intensity, lifecycle, and formation.
Prerequisite(s): GEOG 2506 and GEOG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4524 - Physical Meteorology (3 credits)
Study of the physics associated with cloud and precipitation development, the emission, absorption, and transmission of solar and terrestrial radiation, meteorological acoustics, and atmospheric electricity.
Prerequisite(s): GEOG 3515
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4534 - Numerical Weather Prediction (3 credits)
Scientific basis of numerical weather prediction, including data assimilation, numerical integration, model initialization, physical parameterizations, ensemble methods, and model verification. Overview of numerical errors and their effects on predictability. Current operational forecasting models and the role of models in weather forecasting. Application of knowledge to running a high-resolution numerical weather forecast in a high-performance computing environment.
Prerequisite(s): GEOG 3515 and GEOG 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4554 - Remote Sensing of Atmosphere (1 credit)
Remote sensing technologies used in monitoring weather. Evaluation of Doppler radar products, including base reflectivity, base velocity, storm-relative velocity, and vertically integrated liquid imagery. Could observation through infrared and visible satellite imagery; remote weather station design, set-up and data retrieval.
Prerequisite(s): GEOG 4354
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 4574 - Climate Data Analysis and Programming (3 credits)
Elements of 1-dimensional and high-dimensional climate data storage and formatting. Manipulate and query atmospheric reanalysis, global climate model, and gridded observation datasets. Implement efficient research workflows through the development of computer scripts to statistically analyze climate data.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4764, UAP 4764

GEOG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Geosciences (GEOS)

GEOS 1004 - Earth Science: Our Past, Present, and Future (3 credits)
Introduction to Earth science, including the fundamental concepts of geology in the modern context of humans interacting with the Earth. Formation and evolution of the Earth (history, plate tectonics, the rock cycle, geologic time), internal Earth dynamics (earthquakes, volcanoes, mitigating natural hazards), Earth materials (minerals and rocks, energy and mineral resources), surface processes (Earth system science, hydrologic cycle, global geochemical cycles, oceans and atmosphere, climate, erosion and landscapes), Earth sustainability (resources, environmental change), evaluating geological information and products of research, the scientific approach to problem solving, and the ethical issues associated with geoscience and the environment.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1014 - Evolution of the Earth-Life System (3 credits)
Introduction to the interaction of the Earths processes that shape our planet and its biosphere through time. Application of modern geoscientific inquiry; biological, chemical and physical interactions that are part of the Earth system; distribution of life on Earth (i.e., biogeography); diversity of life over time; the differentiation between science and pseudoscience; ethical issues around human activities and their impact on the Earth-Life system.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1024 - Earth Resources, Society, and Environment (3 credits)
Introduction to the Earths resources including their nature, formation, occurrence, extraction, distribution, consumption, and waste management and disposal using an integrated cradle to grave analysis. Population, the Earths metallic and non-metallic resources, rare earth elements, non-renewable and renewable energy and water. Social, environmental, economic and political impacts resource production and consumption have had historically, currently, and that are predicted into the future including current and future sources of energy in the United States and internationally. Sustainability, water abundance and quality, fracking, climate change, ocean acidification, and ozone depletion.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1034 - Earths Natural Hazards (3 credits)
Fundamentals of Earth processes that drive natural hazards, including earthquakes, volcanoes, tsunamis, hurricanes, tornadoes, floods, climate change and impacts with space objects; impacts of human activities on the Earth; defining and analyzing hazards and risks through testing hypotheses on geologic data; ethical issues arising from hazard mitigation; analysis of uncertainties of scientific information.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1054 - Age of Dinosaurs (3 credits)
Introduction to dinosaur paleontology, including fundamental geological and biological concepts, with focus on how modern paleontologists ask interdisciplinary questions to examine the fossil record. Use of dinosaurs to explore: process and impact of scientific method; geologic processes, geologic time, global change, ecosystems, biogeography; anatomy, evolution, biodiversity, phylogenetic relationships; and media portrayal of extinct animals.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1064 - Climate History: Past, Present, and Future (3 credits)
Introduction to the fundamental components of Earths climate system. Changes of Earths climate at different time scales. Climate change induced by plate tectonics, variations in Earths orbit and transition to and from ice ages. Historical and future changes of Earths climate. Climate models as tools to interpret climate data. Impacts of climate change. Climate ethics and policies.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1104 - Introduction to Earth Sciences Laboratory (1 credit)
Introduction to Earth sciences laboratory, including identification of minerals and rocks, topographic and geologic maps, structural geology, geology impacting humans and humans impacting geology, environmental and social impacts.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

GEOS 1124 - Earth Resources, Society and Environment Laboratory (1 credit)
Laboratory course on Earths resources including their nature, importance, occurrence, extraction, and environmental, social, and political impacts of consumption. Earths resources include metal ores, non-metallic resources which includes surface and ground water and non-renewable (e.g., fossil fuels) and renewable energy (e.g., hydroelectric). Sustainability, water quality and quantity, climate change, and ocean acidification related to resource extraction and consumption.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

GEOS 2004 - Geosciences Career and Professional Development (3 credits)
Introduction to career and professional development in the geosciences, including investigating career options, searching for internships and jobs, discussing topics of ethics, diversity and inclusion, evaluating information resources, collaborating in research groups, and developing skills in technical communication. Restricted to geoscience majors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 2014 - Mission to the Planets (3 credits)
The events and processes that shaped the terrestrial planets; the scientific method (i.e., observations, techniques, and theories) that supports our understanding of these events and processes; the role of science, politics, and engineering and how these impact planetary science missions; ethical issues associated with planetary research; manned and unmanned exploration and how they have shaped our understanding of the planets.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 2024 - Earth's Dynamic Systems (6 credits)
Overview of the geosciences, emphasizing processes operating within and on the Earth now and over the last 4.55 billion years. Earth's systems, cycles and material. Earth's formation, the physical Earth, and plate tectonics. Earth's record, including the fossil record, evolution, origin and diversity of life, and biogeography. History of the Earth-Life system, including key events throughout time. Time and length scales. Climate change and extinction. Field trips required. Restricted to geoscience majors (5H, 3L, 6C), partial duplication of GEOS 1004.
Instructional Contact Hours: (5 Lec, 3 Lab, 6 Crd)

GEOS 2104 - Elements of Geology (3 credits)
Structure of the earth, properties of minerals and rocks, and geologic processes that act on the surface and in the interior of the earth, and integrated geologic systems of importance in engineering and regional planning. For students in engineering and physical sciences. Geology 2104 duplicates material in Geology 1004 and both may not be taken for credit.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 2444 - Geoscience Field Observations (3 credits)
Study of geological processes in the field. Integration of field observations with datasets into conceptual geological interpretations and models. Identification of rock type, lithology and structure in outcrop.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

GEOS 2984 - Special Study (1-10 credits)
Instructional Contact Hours: (1-10 Lec, 1-10 Crd)

GEOS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 3014 - Environmental Geosciences (3 credits)
The roles of geology and geophysics in defining and monitoring the natural environment, with special application to interactions between humans and the geologic environment. Both descriptive treatment and quantitative concepts related to environmental processes involving the solid earth and earths surface, with emphasis on geologic hazards (e.g., earthquakes, volcanoes, landslides and slope failures, flooding, groundwater problems, mineral and rock dusts).
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3024 - Computational Methods in the Geosciences (3 credits)
Development of computational skills aimed at extracting pertinent trends and significance of a wide variety and quantity of highly heterogeneous geoscience data; application of analytical, statistical and signal processing methods for analyzing time-series, spatial and satellite imagery data; tools for producing publication quality maps, graphs, charts, and other visual aids.
Prerequisite(s): MATH 1225 or MATH 1025
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3034 - Oceanography (3 credits)
Descriptive and quantitative treatment of the geological, physical, chemical and biological processes that occur in, or are influenced by, the oceans. The history of oceanic exploration and discovery is addressed.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3044 - Geosciences Outreach (2 credits)
Service-learning through teaching. Identification and development of geoscience outreach activities based on national and state science education standards. Assessment methods for evaluating the effectiveness of outreach activities. Techniques for effective instructional design and communication of geoscience concepts to enrich the general publics awareness of the geosciences.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014)
Instructional Contact Hours: (2 Lec, 2 Crd)

GEOS 3104 - Elementary Geophysics (3 credits)
Acquisition and interpretation of exploration geophysical data. Seismic reflection and refraction methods, gravity and magnetic fields, geoelectrical methods, and geophysical well logging.
Prerequisite(s): (GEOS 1004 or GEOS 2024 or GEOS 2104) and (MATH 1026 or MATH 1226) and (PHYS 2205 or PHYS 2305)
Corequisite(s): PHYS 2206 or PHYS 2306
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3204 - Sedimentology-Stratigraphy (3 credits)
Study of sedimentary basins in a plate-tectonic framework, mechanisms of basin formation, three-dimensional geometry of basin fill, and controls on basin fill. Siliciclastic and carbonate-evaporate rocks as examples of basin fill are discussed in lectures and studied in the lab and in the field. Applied aspects of the course include a discussion of geometries of sedimentary aquifers and reservoirs.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3304, GEOG 3304

GEOS 3404 - Elements of Structural Geology (3 credits)
Introduction to basic geological structures, evolution of microfabrics, development of faults, folds and foliations, stereographic analysis of geological structures, thrust fault geometries, balancing of geological cross-sections, and introduction to the concepts of stress and strain.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3504 - Mineralogy (3 credits)
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester.
Prerequisite(s): CHEM 1035 or CHEM 1055 or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: MSE 3104

GEOS 3604 - Paleontology (3 credits)
Paleontological principles and techniques and their application to the evolution of life, the ecological structure of ancient biological communities, the interpretation of ancient depositional environments, and the history of the earth.
Prerequisite(s): (GEOS 1004 and GEOS 1014) or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3614 - Soils (3 credits)
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant- and earth-science majors. Partially duplicates CSES/ENSC 3134.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3114

GEOS 3624 - Soils Laboratory (1 credit)
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates CSES/ENSC 3134.
Corequisite(s): GEOS 3614
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: CSES 3124

GEOS 3634 - Natural History Collections and Curation (3 credits)
Introduction to museums and natural history collections, with a focus on hands-on curation of specimens to learn standard archival practices and principles. Exploration of campus collections such as the Museum of Geosciences, Massey Herbarium, and Cheatham Vertebrate Collection with particular focus on: specimen acquisition and accessioning; specimen preparation, preservation, and identification; collection labeling, organization, and storage; collection management databases; metadata; emergency response plans; and the role of museums over time for outreach and interpretation. Application of knowledge through final project.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014) or (BIOL 1105 and BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3644 - Paleontological Laboratory Techniques (2 credits)
Laboratory techniques for extracting and preserving paleontological data. Tracing the process a fossil goes through from the field until it is permanently curated. Supervised hands-on experience in an active paleontological laboratory. Independent paleontology information preservation projects. Topics include: philosophy of fossil preparation, mechanical and chemical preparation, conservation and lab materials, digital data and virtual preparation, molding and casting, 3D printing, and collaboration with other museums.
Prerequisite(s): GEOS 1014 or GEOS 1054 or GEOS 2024
Instructional Contact Hours: (2 Lec, 2 Crd)

GEOS 3704 - Igneous and Metamorphic Rocks (3 credits)
Study of characteristics and mechanisms of igneous intrusion at depth in the crust, volcanic phenomena on the surface, and textural and mineralogical modification of rocks at elevated temperatures and pressures of crustal metamorphism. Tectonic aspects of igneous and metamorphic rocks will be stressed.
Prerequisite(s): GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

GEOS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4024 - Senior Seminar (3 credits)
Integration and solution of significant geoscience research problems and case studies by analysis and integration of information across a wide spectrum of geoscience sub-disciplines. Techniques for effective oral and written communication of technical information to experts and non-experts. Independent and team research projects. Analysis of ethics associated with societally-relevant geosciences issues. Ethics and professionalism in geosciences.
Prerequisite(s): GEOS 2004 and GEOS 2024 and GEOS 2444 and GEOS 3204 and GEOS 3404 and GEOS 3504
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4084 - Modeling with Geographic Information Systems (3 credits)
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Course Crosslist: GEOG 4084

GEOS 4124 - Seismic Stratigraphy (3 credits)
Overview of seismic data acquisition and processing methods, seismic wavelets, static and dynamic corrections, and seismic velocities; seismic reflection data interpretation; seismic reflection responses Seismic mapping; seismic stratigraphy and seismic lithology. Consent required.
Prerequisite(s): GEOS 3104 and GEOS 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4134 - Interdisciplinary Issues and Ethics in Water Resources (3 credits)
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4134

GEOS 4154 - Earthquake Seismology (3 credits)
Seismicity and its causes in the context of plate tectonics; determination of earthquake location, size and focal parameters; seismogram interpretation; seismometry; hazard potential; use of earthquakes in determining earth structure.
Prerequisite(s): MATH 2204 or MATH 2204H and MATH 2214 and PHYS 2305 and GEOS 3104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4164 - Potential Field Methods in Exploration Geophysics (4 credits)
Theory and application to engineering, environmental, and resource exploration. Gravity, magnetics, electrical resistivity, self potential, induced polarization, ground-penetrating radar, magnetotellurics, electromagnetic induction.
Prerequisite(s): (MATH 2204 or MATH 2204H) and MATH 2214 and PHYS 2306 and GEOS 3104
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4174 - Exploration Seismology (4 credits)
Theory and application of seismic methods to engineering, environmental and resource exploration: reflection seismics, refraction seismics, and tomography. Data acquisition, digital filtering, data corrections, imaging, interpretation, and forward modeling.
Prerequisite(s): MATH 2204 or MATH 2204H and MATH 2214 and PHYS 2305 and GEOS 3104
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4184 - Geodesy in the Earth Sciences (3 credits)
Study of measurement of Earth 's geometric shape, orientation in space, the gravity field, and how these properties change over time. Geodetic methods of measurement (i.e., GNSS, InSAR, TLS, gravity). Reference frames, geodetic applications, and geodetic advances.
Prerequisite(s): GEOS 1004 or GEOS 1024 or GEOS 1034 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4234 - Vertebrate Evolution (4 credits)
Characterization of the evolution of vertebrates from the fossil record to now. Tracing anatomical features in humans to their origin of different vertebrate groups. Chronicling vertebrate diversification events through extinctions, changes in climate in the last 600 million years, biogeography, and phylogenetic methods. Evidence of evolution through fossils and dissection.
Prerequisite(s): GEOS 1014 or BIOL 2704 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4244 - Morphology of the Vertebrates (4 credits)
Identification of skeletal osteological elements of major groups of vertebrates, including aspects of skeletal functional morphology and homology, with emphasis on extant taxa. Skeletal systems of model and non-model organisms such as fish, amphibians, reptiles, birds, and mammals; specimen care and data management; modern skeletal collection practices.
Prerequisite(s): (GEOS 1014 or GEOS 2024 or GEOS 1054) or (BIOL 1105 and BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4254 - Integrative Earth System History (3 credits)
Study of Earth system evolution, with a focus on critical transitions that shaped the history of the Earth, and the integration and interaction of the atmosphere, hydrosphere, biosphere, and geosphere. Principles of system science, box models, atmospheric and oceanographic processes, microbial processes, isotopic tracers, elemental cycles, and critical transitions in Earth history, including the origin of life, changes in atmospheric composition, climatic events and mass extinctions.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4264 - Sedimentary Basins (3 credits)
Formation, evolution, and characterization of regions of the Earths surface that experience long-lived subsidence and sediment accumulation. Integration of concepts and skills from: stratigraphy, surface processes, tectonics, structural geology, burial/thermal history, geo/thermochronology, and geodynamics; content is relevant to fields such as paleontology, (paleo)climatology, and subsurface resource management. Use of programming/statistical software packages.
Prerequisite(s): GEOS 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4314 - Coastal Hazards (3 credits)
Study of past, current, and future drivers of coastal change and hazards. Integration of concepts and skills from: climatic, isostatic, and tectonic processes that drive sea-level change; geologic (e.g., coastal stratigraphy, microfossils) and instrumental (e.g., tide gauges, satellite altimetry) coastal change reconstructions, models, measurements, and projections. Coastal earthquake, tsunami, hurricane, and storm-surge hazards. Approaches and challenges of communicating coastal hazards to the public. Coastal hazards and public policy.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4354 - Introduction to Remote Sensing (3 credits)
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar and thermal infrared imagery. Digital analysis, image classification and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOG 4354

GEOS 4404 - Advanced Structural Geology (3 credits)
Basic principles of rock behavior under applied, non-hydrostatic stress (experimental and tectonic) and analysis of the geometrical patterns produced. Alternate years.
Prerequisite(s): GEOS 3404
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4614 - Stable Isotope Biogeochemistry (3 credits)
Introduction to the fundamental processes that drive the sorting of carbon, nitrogen, oxygen, hydrogen, and sulfur stable isotopes in modern and past marine and terrestrial systems. Application of stable isotopes to address research questions in a variety of disciplines, including geology, paleobiology, ecology, and environmental sciences. Collect, prepare, analyze, and interpret stable isotope data.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1055H
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4624 - Mineral Deposits (3 credits)
Introduction to the range and variety of metallic and non-metallic economic mineral deposits. Classification of the petrologic and tectonic settings of mineral deposits. Source, transport and depositional mechanisms of mineral deposit formation. Laboratory emphasizes identification of ore minerals, gangue minerals, common host rocks, wall-rock alteration and mineral zoning. Course requirement of 3 hours of GEOS at the 3000-level or above, may be satisfied by taking prerequisite prior to or concurrent with course.
Prerequisite(s): GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4634 - Environmental Geochemistry (3 credits)
Application of quantitative methods of thermodynamic and physicochemical analysis to the study of the distribution and movement of chemical elements in surface and near-surface geological environments. Emphasis on practical approaches to environmental geochemistry.
Prerequisite(s): (MATH 1225 or MATH 1025) and (CHEM 1035 or CHEM 1055) or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4714 - Volcanoes and Volcanic Processes (3 credits)
Study of characteristics and mechanisms of volcanic phenomena, including magma dynamics, origin and chemistry of lavas, physics of eruptions, and characteristics of volcanic products, particularly pyroclastic deposits. Includes focus on volcanism as a general planetary process, on terrestrial tectonic settings of volcanism and on volcanic hazards.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4804 - Groundwater Hydrology (3 credits)
Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow.
Prerequisite(s): (MATH 1226 or MATH 1026) and (PHYS 2205 or PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4824 - Engineering Geology (3 credits)
Application of geological, geochemical, and hyrdogeological principles to engineering problems; relating rock and soil forming processes to engineering properties of geological materials; physical and chemical weathering processes and relationships with engineering properties of soil and rock; effective stress theory and geologic hazards; methods and data types for environmental applications and engineering works; geologic hazards and human-land interactions; professionalism and ethics in the practice of engineering geology.
Prerequisite(s): (GEOS 1004 or GEOS 2024 or GEOS 2104) and (PHYS 2305 or PHYS 2205) and (CHEM 1035 or CHEM 1015) and (MATH 1225 or MATH 1025)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4924 - Tectonics (4 credits)
Overview of modern plate tectonic theory and history. Physical processes driving present-day plate tectonic deformation including continental rifts, rifted margins, continental transforms, strike-slip faults, subduction zones and orogenic belts. Plate kinematic concepts and information about the Earth's structure. Application of scientific method, data analysis, and computational modeling.
Prerequisite(s): (MATH 1025 or MATH 1225) and (PHYS 2205 or PHYS 2305)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4944 - Study Abroad Topics in Geosciences (1-3 credits)
Study of geoscience topics in a global environment. Cross#cultural perspectives on scientific inquiry and knowledge in the geosciences. Application to topics of societal relevance. Field experiences in places of geologic, societal and cultural interest. Specific topics may vary from semester to semester. May be repeated with different content for a maximum of 9 credit hours.
Prerequisite(s): GEOS 2024 or GEOS 2104 or (GEOS 1004 and GEOS 1104)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 9 credit hours

GEOS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

GEOS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4994 - Undergraduate Research (1-19 credits)
May be repeated for a maximum of 4 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 4 credit hours

GEOS 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

German (GER)

GER 1105 - Elementary German (3 credits)
Fundamentals of the German language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 1106 - Elementary German (3 credits)
Fundamentals of the German language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Prerequisite(s): GER 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 1114 - Accelerated Elementary German (6 credits)
Proficiency-oriented approach to elementary German, designed for learners who wish to progress rapidly through the beginning stages of language learning. It develops the four language skills (speaking, listening, reading, writing) in a cultural context. Partially duplicates GER 1105 and 1106.
Instructional Contact Hours: (6 Lec, 6 Crd)

GER 2105 - Intermediate German (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): GER 1106 or GER 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2106 - Intermediate German (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication. I,II
Prerequisite(s): GER 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2114 - Accelerated Intermediate German (6 credits)
Proficiency-oriented approach to intermediate German, designed for learners who wish to progress rapidly through the intermediate stages of language learning. The course strengthens the four language skills (speaking, listening, reading and writing) in a cultural context. Accelerated version of GER 2105-2106.
Prerequisite(s): GER 1106
Instructional Contact Hours: (6 Lec, 6 Crd)

GER 2724 - Introduction to German Culture and Civilization (3 credits)
Examination of major German-language cultural movements, works, and figures from the earliest times to the present. Interdisciplinary exploration of German-language literature, film, art, architecture, music, and theatre in the context of the history of the German-speaking world. Analysis of Germanic culture, values and beliefs, and politics in their European and international context. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 3105 - Grammar, Composition and Conversation (3 credits)
Progressive and comprehensive review of German syntax and morphology. Development of written and oral expression. Development of reading and listening skills and introduction to contemporary public debates through the study of original German materials. Understanding of the role of social, historical, political, and cultural contexts and of fact-based reasoning in communication. Introduction to cultural research in German. Taught in German. GER 3105: review of basic and complex grammatical structures; GER 3106: review of advanced grammatical structures, writing intensive.
Prerequisite(s): GER 2106 or GER 2114
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3106 - Grammar, Composition and Conversation (3 credits)
Progressive and comprehensive review of German syntax and morphology. Development of written and oral expression. Development of reading and listening skills and introduction to contemporary public debates through the study of original German materials. Understanding of the role of social, historical, political, and cultural contexts and of fact-based reasoning in communication. Introduction to cultural research in German. Taught in German. GER 3105: review of basic and complex grammatical structures; GER 3106: review of advanced grammatical structures, writing intensive.
Prerequisite(s): GER 3105
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3125 - German Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken German. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3126 - German Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken German. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3204 - Culture of the German-Speaking Countries (3 credits)
Study of German, Austrian, and Swiss culture and civilization from the Middle Ages to the present, including literature, art, architecture, film, and music.
Prerequisite(s): GER 3104 or GER 3105 or GER 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3305 - Topics in German Culture and Literature (3 credits)
Introduces students to critical issues in German culture and literature. Familiarizes students with artistic, cultural, and socio-historical contexts necessary to analyze artifacts (canonical and non-canonical literature, film, art, architecture, and music). Develops critical reading, writing, speaking, and listening skills in German regarding complex texts, contexts, and concepts. Fosters cross-cultural awareness and intercultural sensitivity. 3305: examines pre-20th-century German cultural and literary developments; 3306: examines cultural and literary developments in the 20th and 21st centuries. Taught in German. Variable content. May be repeated once for credit with different content for a maximum of 6 credits.
Prerequisite(s): (GER 3105 and GER 3106) or (GER 3105 and GER 3204) or (GER 3105 and GER 3306) or (GER 3106 and GER 3204) or (GER 3106 and GER 3306)
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3306 - Topics in German Culture and Literature (3 credits)
Introduces students to critical issues in German culture and literature. Familiarizes students with artistic, cultural, and socio-historical contexts necessary to analyze artifacts (canonical and non-canonical literature, film, art, architecture, and music). Develops critical reading, writing, speaking, and listening skills in German regarding complex texts, contexts, and concepts. Fosters cross-cultural awareness and intercultural sensitivity. 3305: examines pre-20th-century German cultural and literary developments; 3306: examines cultural and literary developments in the 20th and 21st centuries. Taught in German. Variable content. May be repeated once for credit with different content for a maximum of 6 credits.
Prerequisite(s): GER 3105 or GER 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3474 - Topics in German Cinema (3 credits)
Critical issues in the history of German Cinema. Aesthetic characteristics of major periods, with an emphasis on cinematic trends and ways in which films reflect cultural developments in German-speaking countries. Taught in English. Variable content. May be taken twice for credit with different content.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4154 - Advanced Composition and Stylistics (3 credits)
Intensive advanced work in written German. Development of the students ability to write clear, correct, and articulate German in a variety of modes. Style analysis. Writing intensive.
Prerequisite(s): GER 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4304 - Age of Goethe (3 credits)
Major writers of the age of Goethe: Goethe, and Schiller; the development of German Classicism.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4314 - Studies in 19th-Century Literature (3 credits)
Variable content course devoted to the study of 19th century drama, lyric, and prose. May be repeated for credit with different content.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4324 - Studies in 20th-Century Literature (3 credits)
A variable content course devoted to the study of major literary works of the 20th century. May be repeated for credit with different content.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4334 - Special Topics in German Life, Literature, and Language (3 credits)
Variable content course devoted to the study of various aspects of German culture, literature, and language. May be repeated for credit with different content.
Prerequisite(s): (GER 3105 and GER 3106) and (GER 3204 or GER 3305 or GER 3306)
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4794 - Senior Tutorial in German Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. Must be pre-arranged three weeks before end of previous semester. May be taken twice for credit with different content. PRE: one 4000-level German course, major with senior standing, and consent required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

GER 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Greek (GR)

GR 1105 - Classical and New Testament Greek (3 credits)
Introduction to classical/New Testament Greek, for development of reading ability. 1105: Short readings of graded difficulty. 1106: Introduction to the basics of the introduction of language, continued, with the introduction of select longer passages from ancient Greek authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1106 - Classical and New Testament Greek (3 credits)
Introduction to classical/New Testament Greek, for development of reading ability. 1105: Accidence, syntax, and vocabulary, with translation of short readings of graded difficulty. 1106: Accidence, syntax, and vocabulary continued, with the introduction of selected longer passages from ancient Greek authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1205 - Elementary Modern Greek (3 credits)
Fundamentals of modern Greek with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. GR 1205 is for students with no prior knowledge of the language.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1206 - Elementary Modern Greek (3 credits)
Fundamentals of modern Greek with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. GR 1206 is for students who have completed GR 1205 or the equivalent. Completion of 1206 meets the university foreign language requirement.
Prerequisite(s): GR 1205
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 2104 - Greek New Testament (3 credits)
Review and refinement of the language is combined with readings from the New Testament in ancient Greek, with attention to historical context and analysis of the language May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: RLCL 2104

GR 2114 - Readings in Classical Greek Literature (3 credits)
Study of several major writers of ancient Greek literature. Selections from epic poetry, tragedies, philosophical dialogues, history and oratory. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

GR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Hebrew (HEB)

HEB 1105 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 1105

HEB 1106 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): HEB 1105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 1106

HEB 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

HEB 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HEB 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

HEB 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

History (HIST)

HIST 1004 - Introduction to History (3 credits)
Introduces students to the main concepts and issues of discipline of history. Familiarizes students with the Department of History, educational requirements, university resources, and career opportunities for History majors.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1014 - Topics in Reacting to the Past (3 credits)
Introduction to fundamental issues in history through historical simulations. Enacting specific roles in historical situations while improving liberal learning skills, including evaluating evidence, understanding multiple perspectives, writing persuasive essays, and developing public speaking skills. Specific topics may vary from semester to semester. May be repeated one time with different content for a maximum of six credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 1024 - Ancient History (3 credits)
Surveys the civilizations and peoples of Greece, Rome, and the Ancient Near East (including Egypt and Mesopotamia) from the invention of writing around 3,000 B.C. to the fall of the Roman Empire in the fifth century C.E. through study of literature as well as archaeological artifacts. Examines the interactions and interdependencies of these civilizations and considers their enduring influence.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1025 - Introduction to European History (3 credits)
Examines the political, social, and cultural history of Europe since the medieval period. Focuses on the complex interplay between demographic transformation, social and political change, and cultural development. 1025: Explores the legacy of the Roman Empire, the expansion and consolidation of “Europe,” the medieval world and expansion in the Atlantic World. 1026: Explores the rise of Absolutism and the Enlightenment, the Age of Revolutions, imperialism, the rise of new political ideologies and nation-building, and Europe in the twentieth century world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1026 - Introduction to European History (3 credits)
Examines the political, social, and cultural history of Europe since the medieval period. Focuses on the complex interplay between demographic transformation, social and political change, and cultural development. 1025: Explores the legacy of the Roman Empire, the expansion and consolidation of “Europe,” the medieval world and expansion in the Atlantic World. 1026: Explores the rise of Absolutism and the Enlightenment, the Age of Revolutions, imperialism, the rise of new political ideologies and nation-building, and Europe in the twentieth century world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1084, RLCL 1084, SOC 1084

HIST 1115 - History of the United States (3 credits)
Examines the history of the United States through intersections of politics, economics, sciences, the arts and significant social movements. Considers how the modern United States has emerged through the interactions of diverse ethnic, racial, national, class, and religious groups. 1115: pre-Columbian societies through the Civil War; 1116: Reconstruction through present. Sequence recommended as preparation for advanced courses in United States history.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1116 - History of the United States (3 credits)
Examines the history of the United States through intersections of politics, economics, sciences, the arts and significant social movements. Considers how the modern United States has emerged through the interactions of diverse ethnic, racial, national, class, and religious groups. 1115: pre-Columbian societies through the Civil War; 1116: Reconstruction through present. Sequence recommended as preparation for advanced courses in United States history.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1214 - History of the Modern World (3 credits)
An examination of the global significance of the critical political, social, cultural, and international issues in the 20th century.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1215 - Intro to World History (3 credits)
Examine political, economic, social, and cultural change around the world over the course of human existence, with particular emphasis connections and comparisons of human societies across space and time. 1215: Covers early civilizations to 1500 CE. Major themes include the development of human civilization and the interactions of different societies through exchange of people, ideas, goods, and disease. 1216: Covers from 1500 CE to present. Major themes include the spread of European imperialism and resistance to it, development of nation-states, world wars, and post-colonial globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1216 - Intro to World History (3 credits)
Examine political, economic, social, and cultural change around the world over the course of human existence, with particular emphasis connections and comparisons of human societies across space and time. 1215: Covers early civilizations to 1500 CE. Major themes include the development of human civilization and the interactions of different societies through exchange of people, ideas, goods, and disease. 1216: Covers from 1500 CE to present. Major themes include the spread of European imperialism and resistance to it, development of nation-states, world wars, and post-colonial globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1224 - Conquest and Culture in Latin American Empires (3 credits)
Explores major themes and events in the political and cultural history of major empires in Mexico and Peru from 900 to 1600. Examines the emergence of indigenous empires, their confrontation with European conquistadors, and life in the early colonial period. Discusses the cultural collision that occurred when Europeans arrived in the Americas, and complicates the narrative of the conquest. Focuses on the complex interplay between geography, political and economic organization, and social change. Investigates the position of indigenous peoples in pre-Columbian and European empires in Mesoamerica and the Andes. Discussion of the methods and sources to interpret postclassic and early Colonial Latin America.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1354 - Conflict and Security in Modern East Asia (3 credits)
Survey of the 20th century history of five states in northeast Asia, People's Republic of China, Taiwan, Japan, North and South Korea, and the connections between them. Causes and consequences of war, colonization and nationalist movements and their implications for contemporary regional and global relations. Emphasis on cultural concepts, political ideologies, social relations and historical conflicts as background to current security concerns.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1515 - History of Africa (3 credits)
Examines political, economic, social and cultural themes in African history from the beginnings of human civilization to the recent past, with particular emphasis on historical experiences of race, gender, class, religion, ethnicity, and nationality. 1515: Covers early civilizations through the abolition of the slave trade. Examines migrations and trade, the expansion of Islam, and slavery in Africa and the Atlantic and Indian Oceans. 1516: Covers Africa since the nineteenth century. Examines European conquest, and major political, cultural and social changes during the colonial and post-colonial eras.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1516 - History of Africa (3 credits)
Examines political, economic, social and cultural themes in African history from the beginnings of human civilization to the recent past, with particular emphasis on historical experiences of race, gender, class, religion, ethnicity and nationality. 1515: Covers early civilizations thorugh the abolitionof the slave trade. Examines migrations and trade, the expansion of Islam, and slavery in African and the Atlantic and Indian Oceans. 1516: Covers Africa since the nineteenth century. Examines European conquest, and major political, cultural and social changes during the colonial and post-colonial eras.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1764 - History of Rock n Roll (3 credits)
Rock 'n' roll in historic and cultural contexts. Effects on social identity, worldviews, economic justice, cultural appropriation, diversity, power, and traditions. Creative and aesthetic influences in human experience and cultural expression. Significant music figures, movements, and trends in artistic, political, social, technological, and industrial developments in the U.S.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2004 - Historical Methods (3 credits)
Explanation of the discipline of history: its history, philosophies, and methods, with emphasis on historical research.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2054 - Engineering Cultures (3 credits)
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2054

HIST 2104 - Topics and Critical Issues in US History (3 credits)
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in the history of the United States. Emphasis on the study of source materials and historical interpretations of specific themes in American history. Themes grounded in issues of class, race, gender, and equality in US history. Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2114 - Topics and Critical Issues in European History (3 credits)
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in European history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Themes grounded in European history/Europe's role in world that interrogate the concept of "the West." Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2124 - Topics and Critical Issues in World History (3 credits)
Introduction to the problems, methods and fundamental skills of the discipline of history through the study of significant themes and critical issues in world history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Examines political, economic, social, and cultural change at historically specific periods of time around the world with a focus on drawing comparisons and making connections across regional spaces. Specific topics may vary from semester to semester. May be repeated two times with different content for a maximum of 9 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2134 - The Revolution Will Be Televised: Topics in History on TV (3 credits)
Explores topics in history through the lens of specific TV shows or series. Featured shows and topics will vary from semester to semester. Considers how television programs have represented historical events, ideas, and communicated ideas about race, gender, sexuality, class, or culture. May be repeated once with different content for a maximum of 6 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 2166 - History of France (3 credits)
French history from Roman Gaul to the present. 2165: Roman, Medieval, and Renaissance France; Absolute Monarchy. 2166: The Revolution; Nineteenth and Twentieth Century France.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2184 - History of the Balkans (3 credits)
History of Southeastern Europe from the sixth century to the present. Chief themes are movement of peoples, Byzantine and Ottoman Empires, religious conflicts, social developments, and rival nationalisms.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2224 - Ancient Greek and Roman Women (3 credits)
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2224

HIST 2234 - Classics in the Modern World (3 credits)
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2234

HIST 2244 - Cities of Rome (3 credits)
Examines the building development of the ancient city of Rome and selected Roman cities; investigates how social, political, and cultural aspects of private and public architecture in these physical cities both create meaning and preserve memory. Explores the ways in which later cultures, especially through literature, have engaged with the pervasive and persistent influence of ancient Rome, not just as a physical place, but also as a cultural construct.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2244

HIST 2264 - America in the 1960s (3 credits)
Surveys the political, social, and cultural history of the U.S. over the long Sixties (mid-1950s to mid-1970s). Examines the civil rights movement, Vietnam War and antiwar movement, identity politics, cultural revolutions, American liberalism, and American conservatism. Explores how intersection of race, class, gender, ethnicity and age shaped varying experiences of the 1960s. Emphasis on the study of source materials and historical interpretations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2275 - African-American History (3 credits)
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2275

HIST 2276 - African-American History (3 credits)
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2276

HIST 2345 - History of the Middle East (3 credits)
History of the Middle East from the seventh century to today, with emphasis on formation of Islamic civilization, medieval and early modern political systems, European imperialism, and the struggle for independence. 2345: seventh century to 1914; 2346: independence, wars, revolutions, and social change since 1914.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2346 - History of the Middle East (3 credits)
History of the Middle East from the seventh century to today, with emphasis on formation of Islamic civilization, medieval and early modern political systems, European imperialism, and the struggle for independence. 2345: seventh century to 1914; 2346: independence, wars, revolutions, and social change since 1914.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2355 - History of China (3 credits)
China from prehistory to the present. Special attention to political, social, economic, and cultural developments. 2355: Prehistory, Imperial China to the sixteenth century; 2356: late Imperial China to modern and contemporary China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2356 - History of China (3 credits)
China from prehistory to the present. Special attention to political, social, economic, and cultural developments. 2355: Prehistory, Imperial China to the sixteenth century; 2356: late Imperial China to modern and contemporary China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2364 - History of Japan (3 credits)
Political, social, economic, and cultural development of Japan from earliest times to present; emphasis on problems of modernization in the nineteenth and the twentieth centuries.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2374 - Gods and Kings in Premodern India (3 credits)
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2374

HIST 2384 - Gandhi in the Making of Modern India (3 credits)
History of India since approximately 1700, with particular focus on Gandhis influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhis role in political, social, cultural, and religious movements of the early 20th century, and Gandhis legacy in the independent states of South Asia and the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2384

HIST 2394 - Tofu to Tikka: Food in Asian History (3 credits)
Exploration of the evolution and alterations of food and cuisines throughout Asian history. Examination of the economic, geographical, political, philosophical/religious, and social underpinnings of food in premodern Asian societies; influence of the Columbian Exchange of Asian and global cuisines; Euro-American imperialism's impact on food and society in Asia and in the European and American metropoles; emergence of national cuisines in Asia; and Asian food in the post-colonial diaspora.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2394

HIST 2484 - Modern Germany (3 credits)
Political, social, economic, and cultural history of Germany since 1815. Discussion of the origins, experience and impact of political ideologies and national unification/reunification, colonial expansion, Nazism, war and genocide, and the role of Germany in Europe and the world. Diverse perspectives on German history and its implications through primary and secondary source materials. Particular focus on historiographical interpretations of the German past.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2494 - Cities in History (3 credits)
Examines the changing conditions of urban life and the shifting roles that cities have played in U.S. history. Identifies transformations and movements in physical development, including urban form, architecture, urban planning, infrastructure, and environmental conditions. Details the processes of immigration and the consequences of demographic change in cities. Analyzes the contests over politics arising from these urban changes.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2504 - Crime and Punishment in American History (3 credits)
Analyzes changing understandings of crime and punishment from the Colonial Era to the Age of Mass Incarceration. Considers how factors of race, ethnicity, class, and gender intersected with changing ideas of criminality and punishments.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 2504

HIST 2514 - U.S. Food History (3 credits)
Introduction to the history of food in the United States. Examines food cultures, food systems, food industries, nutrition, government regulation, inequalities, and environmental effects of food and agricultural production. Studies these topics across different demographics in the United States and its global context, with attention to change over time.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2524 - History of Agriculture (3 credits)
Survey of agricultural history in the United States, with comparative global case studies. Examination of indigenous practices, labor, development of market economies, relationships among plants and animals, scientific and technological change, landscape transformation and sustainability, food systems, and inequality and exploitation within cultures and societies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2534 - America at War (3 credits)
The United States at war from the American Revolution to the War on Terror. Emphasis on how U.S. policymakers have justified war, popular understandings of "the enemy," the merits and limitations of distinctions between civilians and service members, and the role of technological innovation. Engagements with interdisciplinary and intersectional perspectives with a war and society approach.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2544 - U.S. South: Pre-Colombian to 1865 (3 credits)
Surveys history and cultures of the U.S. South from the Pre-Colombian era to the modern South. Analyzes the enslavement and emancipation of Black southerners, slave resistance, the impact of capitalism, Reconstruction, the creation of the Lost Cause mythology and Jim Crow segregation. Examines the political and economic influences of the region from the emergence of abolitionist thought, populism, the long struggle for racial equality, and the creation of the Sunbelt. Special emphasis placed on struggles for social justice, civil rights and demographic changes within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2554 - U.S. South: 1865 to Present (3 credits)
Surveys history and cultures of the U.S. South from the Pre-Colombian era to the modern South. Analyzes the enslavement and emancipation of Black southerners, slave resistance, the impact of capitalism, Reconstruction, the creation of the Lost Cause mythology and Jim Crow segregation. Examines the political and economic influences of the region from the emergence of abolitionist thought, populism, the long struggle for racial equality, and the creation of the Sunbelt. Special emphasis placed on struggles for social justice, civil rights and demographic changes within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2604, STS 2604

HIST 2624 - Topics in the History of Data in Social Context (3 credits)
Examination of the meaning of data in historical context. Exploration of how historical context shapes classification, collection, and interpretation of data. Analysis of data as a meaningful category of human experience. Variable content. May be repeated once for up to six (6) hours of credit.
Pathway Concept Area(s): 1A Discourse Advanced, 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 2715 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2715

HIST 2716 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2716

HIST 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2724, LAHS 2724, STS 2724

HIST 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 3004 - Colonial America (3 credits)
Critical analysis of early American society. Founding and development of the colonies in the 17th century; 18th century colonial life.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3014 - The American Revolution (3 credits)
Causes, nature, and results of the American Revolution, 1763- 1789.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3054 - The American Civil War (3 credits)
Causes, course, and consequences of the American Civil War. Emphasis on transformations in regional and national identity, race relations, the status of African Americans, gender roles, military affairs, and the United States place on the world stage. Develop skill in written and oral discourse.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3084 - Recent America, 1917-Present (3 credits)
Social, economic, cultural, and political history of America from the entry into World War I, the turbulent 1920s, the Great Depression, the New Deal, World War II, postwar prosperity, the Cold War, social and cultural ferment, Vietnam, Watergate, to the new anxieties about the limits of power in the 1980s.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3105 - Women in U S History (3 credits)
Roles of women from colonial settlement to the present. Special attention to family experiences, political agendas, and economic contributions of women and to social construction of gender identities. 3105: to 1865; 3106: since 1865.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3106 - Women in U S History (3 credits)
Roles of women from colonial settlement to the present. Special attention to family experiences, political agendas, and economic contributions of women and to social construction of gender identities. 3105: to 1865; 3106: since 1865.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3124 - Murder in American History (3 credits)
Considers how the definition of murder as a crime has changed from the colonial period to the present day. Uses murder cases to study the dynamics of American society in condemning, condoning, or celebrating murder. Asks how cultural factors, including racial prejudice, gender stereotypes, beliefs about sexuality, and class status affected the act of killing, media coverage of the event, societal reactions, and the execution of justice. Topics covered include abortion, lynching, vigilante justice, and the evolution of the legal system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 3124

HIST 3134 - Sports in American History (3 credits)
Impact of sports in American history. Emphasis on the impact of team sports (college and professional basketball, baseball, and football) and individual sports (golf, boxing, and automobile racing) on the development of American society and culture.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3144 - American Environmental History (3 credits)
Explores interactions between Americans and the environment from the time of European contact to the recent past. Traces the sometimes unexpected ways in which nature has shaped history, humans have altered the natural world, environmental attitudes have evolved, and environmental inequalities have arisen.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3164 - Sexuality in American History (3 credits)
Examines the changing social and cultural meanigns of sexual behavior and identity in American life from the colonial era to the present. Explores relationships between sexuality and power, culture and politics, and government regulation with consideration of theoretical frameworks of interpretation. Focuses on dynamics of race, ethnicity, gender, and class.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3174 - Native American History (3 credits)
The Native experience in North America or Latin America from 1491 to present. Emphasis on social diversity and organization, resistance to colonization, leadership and cultural change, and political sovereignty among indigenous peoples. Methods for interpreting a variety of primary sources, including texts, material culture, and archaeological findings. Engagements with shifting historiographical perspectives and political movements for recognition of Native sovereignty.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3174

HIST 3184 - Food Sovereignty (3 credits)
Food sovereignty, the right to produce and consume culturally relevant food, as a set of practices and as a social movement through comparative case studies. Origins of food sovereignty in response to effects of colonialism, the green revolution, and the global corporate food system on peasant and Indigenous subsistence livelihoods and the concept's transformation through dialogue with indigenous agricultural knowledge and poor peoples' environmentalism. Food sovereignty's challenge to the dominant food system and conceptions of development, how groups implement this vision of democratized social and productive relations through projects of agroecology and land reform, and its potential in the context of ecological calamity.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3184

HIST 3214 - History of Appalachia (3 credits)
Early settlement, religion, the pre-industrial economy, the coming of the coal and lumber industries, labor activism, politics, migration, and regional identity.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3214

HIST 3224 - History of Virginia (3 credits)
Social, political, cultural, and economic developments in Virginia, from the sixteenth century to the present.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3234 - The North American West (3 credits)
A study of the peoples and history of the North American West from the sixteenth century through the twentieth.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3254 - The Vietnam War (3 credits)
A critical study of the causes and consequences of the Vietnam War, 1945-1975. Analysis of Americas strategic and military objectives, the nature and conduct of the war, and the growth of the antiwar movement at home.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3274 - The Greek City (3 credits)
History of the ancient Greek city-state (polis) from the Archaic period (800-500 BC) to the creation of the Roman Empire. Principal topics are: origins and definition of the polis; Greek colonization throughout the Mediterranean and Black Seas; the struggle for autonomy in the Classical and Hellenistic periods; and the Hellenizing impact of the polis on non-Greek populations.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3284 - The Roman Revolution (3 credits)
History of the Roman world from 264 B.C. to A.D. 180. Particular attention to the three themes of imperialism, revolution, and empire through extensive reading of the contemporary authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3294 - Roman Britain (3 credits)
Examines the social, political, and military origins of early England from Stonehenge to the Norman Conquest; emphasis on archaeology and material culture; and the legacy of the Romans and Romanization on forging a British identity.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3304 - The World of Alexander the Great (3 credits)
Examines the life and times of Alexander the Great and the Hellenistic World, a new cosmopolitan multicultural world initiated by his conquests. Analyzes the rise of Mecedon, the accomplishments and powers of Alexander, and discusses the world forged after him through analysis of literary and non-literary primary sources.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3314 - The Later Roman Empire (3 credits)
Roman Empire in the west from A.D. 180 to A.D. 476 and in the east from A.D. 476 to A.D. 1071. Particular attention to the causes of the fall of the empire in the west and to the Byzantine Empire in the east until the coming of the Turks and the Christian Crusaders.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3324 - The Medieval World (3 credits)
Characteristic thought and institutions of high and late Middle Ages.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3334 - The Renaissance (3 credits)
The Italian Renaissance in its European context. Emphasis upon the culture and institutions of Italian states from 1300 to 1500.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3344 - The Era of The Reformation (3 credits)
Development of Protestantism and reformation of the Catholic Church from 1500 to about 1600. Emphasis upon social, political, and economic factors as well as theology. Examination of conflicts engendered by the reformation movements.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3354 - Reform and Revolution in Early Modern England (3 credits)
Examines the political, social, economic, and religious history of early modern England. Focus on the English Reformation and descent into Civil War and Revolution. Discussion of the Houses of Tudor and Stuart and their roles in radically transforming England into a constitutional monarchy in which the rule of law reigned supreme. Engagement with diverse perspectives on the religious, social, and political upheaval of the sixteenth and seventeenth centuries through focused study of primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3364 - The Age of Revolution and Napoleon (3 credits)
The French Revolution in its European and global context, with particular attention to social and political causes of unrest, strategies of popular mobilization, debates about authority and order, the emergence of empires, and the long-term implications of revolutionary change.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3374 - French Empire (3 credits)
History of French empire from the seventeenth century to the present, in the Carribean, Canada, Asia, North America and Sub-Saharan Africa. Considers indepdendence movements and the effects of post-colonial migrations on metropolitan France. Focus on issues of religion, race, and human rights
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3484 - Nazi Germany: History and Memory (3 credits)
Causes, course, and consequences of the rise of National Socialism in Germany. Political, economic, social, and cultural aspects of life in Germany. Conditions of Weimar Germany; fascism; the emergence of the Nazi Party and its acquisition, exercise and abuse of power; transformation of German society; the problem of Hitler; the Second World War and Holocaust; and memory and representation of the Nazi period.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, and personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3494, RLCL 3494

HIST 3504 - The Age of The Crusades (3 credits)
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3504

HIST 3534 - Modern Military History (3 credits)
Evolution of warfare in its political and social setting since the French Revolution. Discussion of both European and American military institutions.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3544 - World War II (3 credits)
Examines the origins, nature, and consequences of the Second World War in transnational perspective. Discussion of social, economic, political and diplomatic conditions that led to and shaped the conduct of the war. Engagement with diverse perspectives on the war and its implications through primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3554 - Age of Globalization (3 credits)
An examination of historical forces that have shaped patterns of globalization, with emphasis on the late twentieth and twenty-first centuries. Key themes: debates about the origins of globalization, causes and consequences of global inter-relatedness, influence of key people, events, and ideas on patterns of globalization, and the effects of disease, technology and environment on processes of globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3564 - The Cold War (3 credits)
Examines politics, society, and culture of the Cold War in transnational perspective. Discussion of origins of the Cold War and the emergence of superpowers; cultural, economic and territorial imperialism in the Cold War; the role of ideology; lived experience and the legacy of the Cold War. Engagement with diverse perspectives on the Cold War and its implications through primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3594 - The Rise of Modern Latin America (3 credits)
Major themes and issues in Modern Latin American History. Discussion of the rise of Latin American nations, stressing the internal and external challenges new republics confronted during the nineteenth century and the opportunities and conflicts of the twentieth century.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3604 - Russia to Peter the Great (3 credits)
Russian history from the founding of Russia in the ninth century to the reign of Peter the Great in the early eighteenth century, with special attention to political developments, changes in society and culture and regional context.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3614 - Imperial Russia (3 credits)
Russian history from Peter the Great to the Revolution of 1917, with special attention to political developments, changes in society and culture, and the impact of the regional context.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3624 - Health and Illness in African History (3 credits)
Examines key subjects and themes in the history of health, medicine, and disease in African history. Topics include indigenous health systems, colonial medicine, and post-colonial health crises, including HIV/AIDS.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3644 - Twentieth-Century Russia (3 credits)
The history of the Soviet Union from 1917 to the present, with particular emphasis on collectivization, industrialization, ideology, international relations, and other factors that have determined the peculiar character of the Soviet state.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3654 - Arab-Israeli Conflict (3 credits)
Examines the origin and evolution of the Arab-Israeli Conflict from the late Ottoman era to present. Considers a variety of perspectives on the major events, places, people and history of the conflict, including the British Mandate period, independence, and post-1967. Connects the relationship between events and ideas in Palestine/Israel and their local, regional and global significance through analysis and synthesis of primary and secondary texts. Promotes interpretation of the conflict and potential solutions in written and oral form, both from the student's own and alternative points of view.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3664 - Revolutionary China (3 credits)
Ideological and institutional development of the Chinese Communist movement since 1920; emphasis on problems of historical change in modern China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3674 - Topics in Chinese History (3 credits)
Examination of variable topics in Chinese history, ranging from the beginnings of civilization to the recent past. Examines the primary sources and histriographic debates of a particular issue. Explores the diversity within China and its relatiionship with the rest of the world. Can be repeated with different content up to 9 hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3694 - History through Film (3 credits)
This course introduces students to critical issues in history and representation, utilizing film to analyze central historical issues. The specific thematic content is variable. Course may be repeated for up to 9 credits.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3705 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3705

HIST 3706 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3706

HIST 3714 - War and Medicine (3 credits)
Examines the relationship between war and medicine. Focus on suffering and care during and after major conflicts, both on the battlefield and the home front. Emphasis on race, class, and gender.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3724 - History of Disease, Medicine, and Health (3 credits)
Development of Western concepts and institutions of disease, medicine, and health with emphasis on nineteenth century to present. Social construction of disease, and relationship between health and social, economic, and political structures. Special attention to roles of race, class, gender and ethical issues in medical care and research, and to the lived experience of suffering, treatment and healing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3734 - History of Modern Biology (3 credits)
Exploration of the history of biology during the nineteenth century and twentieth centuries, including developments in evolutionary biology, genetics and molecular biology, biology and race, and conservation biology. Emphasis on biology's reciprocal relationship with society, how it has helped shape ideas of race and ethnicity, and the ethical dilemmas it has generated.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3734

HIST 3744 - Social History of Film (3 credits)
This course introduces students to critical issues in the social history of film, examining the production and consumption of film in specific historical moments as well as the effects of film on society, culture, and politics. The specific thematic content is variable. May be repeated with different content for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3754 - Public History (3 credits)
Investigation of the ways in which historians research, interpret, and present the past to the public.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3764 - Oral History: Methods and Practices (3 credits)
Explores the theory and methodology of oral history practice. Considers the use of oral history interviews in historical research, and explores questions of ethics, interpretation, and the construction of memory. Includes training in technical operations and a variety of interview techniques, transcription, and historical use of interviews.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3774 - Digital History (3 credits)
Develops skills and methods for researching and presenting history in a digital environment, with special emphasis on use of digital media as a tool for public historians.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3914 - Critical Reading and Analysis in History (3 credits)
Develops critical reading skills in history. Demonstrates that historical knowledge is part of a scholarly conversation that grows and evolves over time. Assesses the critical role of interpretation in history, investigates historical controversies and debates, and develops skills to evaluate historiographical trends.
Prerequisite(s): HIST 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 3954B - Study Abroad (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

HIST 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4004 - Topics in Social and Cultural History (3 credits)
Selected topics in social and cultural history. May be repeated with different content. 3 other hours of history and junior standing required.
Prerequisite(s): HIST 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ART 4014, EDCI 4014

HIST 4864 - Internship (6 credits)
Placement in historically relevant work in one of a variety of settings. These may include museum interpretation and management, archival management, editing, historic preservation and more. Demonstrate historical research and communication skills. Plan with others in a professional setting. Apply disciplinary skills to site-based contemporary problems and situations. Evaluate the experience. P/F only.
Instructional Contact Hours: (6 Lec, 6 Crd)

HIST 4914 - History Research Seminar (3 credits)
Variable topic, writing-intensive, capstone course for history majors. Provides in-depth knowledge of a specific historical subfield. Utilizes archival historical sources, online research databases, and existing literature to create an original work of historical scholarship. May be repeated with different content up to 6 hours. Junior standing or above required.
Prerequisite(s): HIST 3914 or HIST 3904
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Horticulture (HORT)

HORT 1264 - Landscape Skills Practicum (1 credit)
Relevant skills important for the success in the landscape industry. Safe equipment operation, landscape, irrigation and hardscape installation, management and estimating techniques, marketing and sales strategies, and arboriculture methods.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 2134 - Plants and Greenspaces in Urban Communities (3 credits)
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2134

HORT 2144 - Indoor Plants (3 credits)
Basic horticultural principles, identification and cultural criteria applicable to foliage and flowering plants grown indoors. Specific plant groups discussed include ferns, cacti and succulents, and carnivorous plants, among many others.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2164 - Floral Design (3 credits)
Fundamental art theory, historical and cultural influences, tools and techniques as applied to current floral art. Emphasis on applied experiential learning through designing, building and producing acceptable floral displays for home and public environments. Sustainable and ethical practices in growing and purchasing flowers. Fee $128.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 2184 - Plants, Places, and Cultures in a Global Context (3 credits)
Impact of worldwide production and trade in fruits, vegetables, and cut flowers (horticultural commodities) on societies, cultures, economies, politics, and environment. Case studies covering history, economics, social/cultural impacts of producing fruit, vegetables, tea, coffee, and other horticultural crops in producing and consuming countries. Case studies illustrate inextricable interactions and interconnectedness between horticultural crops and cultures.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2224 - Horticulture Science and Industry (2 credits)
Survey course of horticultural crops (fruits, vegetables, ornamentals) and enterprises. Includes plant science and business aspects of horticultural production and service industries, and introduces related issues and emerging technologies such as work force characteristics, organic production, and biotechnology. I.
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 2234 - Environmental Factors in Horticulture (3 credits)
Principles and practices in managing environmental factors - temperature, water, light, atmospheric gases and pollutants, and soil and minerals - that influence growth and production of horticultural plants.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2244 - Plant Propagation (3 credits)
Principles and practices of plant propagation by sexual and asexual methods.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

HORT 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 2304

HORT 2834 - Sustainable Agriculture Practicum (3 credits)
Hands-on training in sustainable agricultural production at a student-operated vegetable and fruit farm. Participation in tasks required in managing a diversified sustainable horticulture operation, including planting, pest management, irrigation, and post-harvest handling. Discussion of soil fertility, planning, efficiency, food safety and community food systems. May be repeated with different content, for a maximum of 6 credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

HORT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 3114 - Wines and Vines (3 credits)
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 3114

HORT 3324 - Herbaceous Landscape Plants (3 credits)
Identification, growing requirements, culture, landscape use, physiology, and propagation of native and non-native herbaceous landscape plants for temperate environments. Ornamental annuals and perennials; cultivated wildflowers, plants for wetland and aquatic systems.
Prerequisite(s): HORT 2244
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3325 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3326 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3354 - Trees in the Built Environment (3 credits)
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment.
Prerequisite(s): (FREC 2314 or BIOL 2304 or HORT 2304) and (FREC 2324 or HORT 3325 or HORT 3326)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3354

HORT 3664 - Hardscape Materials and Installation (2 credits)
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction methods, and business aspects required for hardscape construction.
Prerequisite(s): HORT 2224
Instructional Contact Hours: (6 Lab, 2 Crd)

HORT 4004 - Horticulture Seminar (1 credit)
Assessment of fundamental horticultural skills developed through academics and employment. Includes career placement preparation and problem solving through research and production project design and implementation using a team approach. Junior standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)

HORT 4205 - Public Gardens Maintenance and Management (1 credit)
4205: Principles and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Pre: Junior standing required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4206 - Public Gardens Maintenance and Management (1 credit)
4205: Principals and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/accessions curation and database management; personnel and financial management issues unique to public gardens. Junior status required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4324 - Greenhouse Management (3 credits)
For persons who intend to manage or advise those managing commercial or institutional greenhouses. Includes greenhouse construction, environmenal controls, disease/insect identification and management, control of plant growth, root-zone management, and marketing and management principles specific to greenhouse operations. Pre: Coursework or experience in plant growth and environmental management required.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4334 - Greenhouse and Controlled Environment Agriculture Management (3 credits)
Managing commercial or institutional greenhouses and/or controlled environment operations. Construction, environmental controls, disease/insect identification and management, control of plant growth, root-zone management. Marketing, accounting, and management principles specific to greenhouse and controlled environment operations.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4344 - Production of Food Crops in Controlled Environment Agriculture (3 credits)
Controlled environment agriculture. Study of major hydroponic systems used in the production of horticultural food crops. Crop life cycles, nutrient requirements. Cost analysis and troubleshooting common problems that arise in controlled environment systems.
Prerequisite(s): HORT 4334
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4504 - Landscape Contracting (2 credits)
Capstone course for students entering the landscape contracting industry. Includes contracts, site plan interpretation, cost estimation and bidding, project sequencing, business marketing, irrigation design, and current issues. Emphasis on real-world skills and problem solving. Pre: Senior Standing Required.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HORT 4545 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4546 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction. 4545, I; 4546, II.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, LAR 4554, SPIA 4554

HORT 4614 - Ornamental Plant Production and Marketing (3 credits)
In-depth production and marketing of woody and herbaceous plants in wholesale nursery and floriculture/greenhouse and related retail outlets. Includes production laboratory.
Prerequisite(s): HORT 2234 and HORT 2244 and HORT 4324 and AAEC 2434
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 4644 - Small Fruit Production (3 credits)
Propagation, production, and marketing of small fruit crops for the mid-Atlantic region. Emphasis on sustainable practices, market sectors, and health and nutritional benefits. Blueberries, strawberries, brambles and other crops.
Prerequisite(s): HORT 2234 and HORT 2244 and AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4654 - Viticulture (3 credits)
Overview of grapevine growth and development, factors affecting yield and grape quality, and regional industry. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4744 - Plant Establishment and Environmental Design (3 credits)
Plant establishment and environmental design process for sustainable landscapes emphasizing the relationship between design of human-constructed landscapes and ecosystems at larger scales. Site assessment, urban soils, site rehabilitation, plant response to disturbed environments, green infrastructure and other contemporary landscape forms. Plant selection, sourcing, and installation to achieve environmental design goals. Emphasis on hands-on, experiential learning to achieve sustainable landscapes. Pre: Senior Standing.
Prerequisite(s): HORT 2134 or FREC 2134 or CSES 3134 or ENSC 3134 or CSES 3114 or ENSC 3114 or GEOS 3614 or LAR 1254
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 4764 - Vegetable Crops (3 credits)
A comprehensive study of major and minor vegetable crops of Virginia, the U.S., and world in relation to production practices, crop development, nutritional value, and quality characteristics.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4784 - Vegetable Seed Production (2 credits)
The study of production agriculture or reproductive biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology. Pre: 4764 or 2244 or equivalent experience in vegetable crops, plant propagation, or plant growth and development.
Prerequisite(s): HORT 4764 or HORT 2244
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4794 - Medicinal Plants and Herbs (3 credits)
Comprehensive study of medicinal plants/herbs history, production, processing, lore and documented scientific benefits. Traditional plant medicinal practices of Native Americans, Chinese, Indians, European and African cultures will be contrasted with use of contemporary herbal products.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4835 - Organic Vegetable Production (2 credits)
Detailed practices in organic vegetable production. Issues in starting organic production, profitability, organic transition strategies and organic certification.
Prerequisite(s): HORT 2254 and ALS 3404
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4836 - Organic Vegetable Production (2 credits)
Detailed practices in organic vegetable production. Issues of initial and improving soil quality in organic systems, factors that affect produce quality and whole-farm weed/disease/pest management.
Prerequisite(s): HORT 4835
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4845 - Organic Vegetable Production Laboratory (1 credit)
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures.
Corequisite(s): HORT 4835
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4846 - Organic Vegetable Production Laboratory (1 credit)
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures.
Corequisite(s): HORT 4836
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Hospitality and Tourism Management (HTM)

HTM 1414 - Introduction to Hospitality and Tourism Management (3 credits)
Hospitality & Tourism industry segmentation, management structures and practices, the significance of service delivery, economic impact of tourism and career opportunities. Concepts examined through readings, case studies and industry gues speakers.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 2104 - Careers in Hospitality and Tourism (1 credit)
Provide students with an early start on understanding and identifying the many career options in the field of Hospitality and Tourism Management. In-depth focus on the different skills and training necessary for various career paths, including core hospitality and tourism management, hospitality and tourism business acumen, and hospitality and tourism strategy and innovation. Emphasize the importance of personal job search strategies and provide networking opportunities with leaders in the industry. Students will create professional materials, including resumes and online profiles. Serves as a foundational course in preparing students for career success in the Hospitality and Tourism Management field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

HTM 2314 - Introduction to International Business (3 credits)
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 2314

HTM 2434 - Hospitality Sales (3 credits)
A comprehensive study of the management of the sales function and its role in the overall financial performance of hospitality operations.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2454 - Global Travel & Tourism Management (3 credits)
Introduction to travel and tourism both domestically and abroad. Includes topics such as the history, sociology and psychology of tourism; the tourism system, including private industry, associations and governing bodies; measuring and predicting travel motivations, behavior, and demand; and management issues in a global context. Course concludes with an international travel research final project.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2464 - Designing the Service Experience (3 credits)
An overview of the service industry, its historical and economic importance, social, psychological and cultural impacts and future trends. Emphasizes the unique characteristics and management challenges of service organizations.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2474 - Introduction to Meetings and Convention Management (3 credits)
A study of the meetings and convention industry. Focus on the components and processes involved in developing and conducting meetings and conventions.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2514 - Catering Management (3 credits)
Introduces students to various venues in which catering services can be offered, and presents an overview of the functions, processes, and controls found in successful catering management and operations; emphasis is placed on the sales/marketing aspects of the business.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2954 - Hospitality and Tourism Study Abroad (3 credits)
This course provides students with an international hospitality and tourism management business experience. It is only offered as part of a program outside the United States. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. This course can be taken twice for a maximum of six credit hours. Sophomore standing and a minimum GPA of 3.0 required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HTM 2964 - Field Study (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 3044 - Private Club Management (3 credits)
Develop an understanding of the private club sector of the hospitality industry. Topic areas are divided into club fundamentals, revenue-generating operations within clubs and support functions/departments of club operations. Junior standing as well as background courses in basic financial management are suggested.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3244 - Franchising and Ownership in the Services Industries (3 credits)
Theory and practice of franchising as a form of business ownership and a vehicle for entrepreneurship. Contemporary issues related to franchising in different segments of the services industries including hospitality and tourism. Legal aspects, financial viability, ethical issues, and agency relationships in franchising. Franchise concept development, franchisor-franchisee relationship, franchise agreements, family business, minority franchising, and international franchising. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3414 - Chef Lab: Culinary Operations Management (4 credits)
Food and kitchen safety, hazard analysis, purchasing, recipe development, costing, and volume food preparation, in a commercial kitchen lab experience one day per week along with a two hour per week lecture. Design/Lab Studio. Pre: Sophomore standing.
Instructional Contact Hours: (2 Lec, 2 Lab, 4 Crd)

HTM 3424 - Event Management (3 credits)
Management of special events in the hospitality and tourism industry. Organizational functions necessary for designing a broad range of special events, using formal elements of design to deliver successful events through use of effectively designed floor plans, event flow and logistics, risk management and contingency planning as well as analyzing the factors that influence an events success. Examine ethical issues at play in the context of modern event planning and implementation. Study review processes, evaluation methods and techniques used in events management. Sophomore standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3444 - Hospitality Financial Management (3 credits)
The application of accounting, finance, and cost control principles to hospitality industry organizations. The focus of this course is to provide future food service and lodging organization managers with the ability to handle the unique problems regarding financial analysis and cost control in this industry.
Prerequisite(s): ACIS 2116 and ECON 2006
Corequisite(s): FIN 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3484 - Socio-Cultural Impacts of Tourism (3 credits)
A study of both historic and current impacts of tourism on family, community, culture, government, globalization, and the environment at the domestic and international levels. The course uses a sustainable tourism framework to examine the complex ways in which tourism both affects and is affected by modern society worldwide. Includes topics such as eco-tourism, volunteer tourism and space tourism.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3524 - Lodging Management (3 credits)
Organization, function, and management of lodging operations. Current issues and management challenges in the lodging industry. Applications of revenue management to lodging systems. Pre: Sophomore standing
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

HTM 3954 - HTM Study Abroad (1-6 credits)
This course provides students with an international hospitality and tourism management business experience. Students will be required to apply their knowledge and skills from their Pamplin College of Business core courses within this course. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. Pamplin College of Business majors must have been approved for upper division course- work.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

HTM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4334 - Sustainable Entrepreneurship and Innovation in Hospitality & Tourism (3 credits)
Analysis of hospitality and tourism innovative and entrepreneurial enterprises to pursue sustainable growth. Analyze the sustainability of hospitality & tourism business ideas regarding growth opportunities considering societal, demographic, and environmental changes from a variety of sources. An examination of the key elements of sustainable entrepreneurship for hospitality and tourism enterprises that apply across a range of business models. Includes a field based, experiential learning project where teams collaborate to analyze data from multiple sources to develop and execute business ideas for existing or new enterprises. Pre: Junior standing.
Prerequisite(s): MGT 2064 or AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4354 - Information Technology and Social Media in Hospitality and Tourism (3 credits)
Introduction to the strategic use of information technology (IT) in todays hospitality and tourism organizations. Includes the most current and widely used information systems in operation, management, and e-business in hospitality and tourism as well as identification, discussion and debate of the ethical issues associated with these systems. Study of social media as a marketing tool for hospitality and tourism businesses. Examine impacts of IT on organizations and the industry as a whole. Pre: Sophomore standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4414 - Restaurant Management: Design and Innovation (3 credits)
Reviews organizational structures, terminology, and categories associated with restaurant management. Discusses principles of restaurant management, including concept design development, financial analysis, daily operations, and customer service. Focuses on emerging trends in technology and innovation. Case study discussions of current issues and challenges in the industry, development of comprehensive restaurant business plan, and "Training for Intervention Procedures" (TIPS) certification.
Prerequisite(s): HTM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4434 - Event and Experience Management Senior Workshop (3 credits)
Senior experiential learning workshop to integrate and apply ethics, research, and design concepts from past coursework by engaging in actual professional events and experiences. Explore and understand the complexity of planning, coordination, and evaluation of events and the impact on the human experience. Capstone for Pathways Minor in Event & Experience Management. Pre: Senior Standing; Registered for the Event and Experience Management Pathways Minor.
Prerequisite(s): HTM 3424
Pathway Concept Area(s): 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4444 - Winery Tourism (3 credits)
The course focuses on the role of wine and wineries in tourism, wine marketing and management in the hospitality industry, and examines the components of a winery. Students must be 21 years of age due to the inclusion of wine tasting in the course. COURSE FEE: $18.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4454 - Hospitality Revenue Management (3 credits)
Examines lodging and foodservices Revenue Management (RM) issues. Customer-centric approach, explores RM from various traditional academic perspectives, including economics, pricing, forecasting, consumer behavior, accounting, finance, and human resources. Management-oriented, emphasizes practical aspects of decision-making. Applies theoretical concepts through class discussion, group projects and individual assignments.
Prerequisite(s): HTM 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4464 - Human Resources Management in the Hospitality Industry (3 credits)
An overview of the concepts of human resources management as applied to the specific environments within the hospitality industry.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4474 - Hospitality & Tourism Law (3 credits)
Managerial approach to the law that applies to hotels, food-service establishments, events, and tourism; special focus on manager's duties to guests. Key concepts covered include contract and property law, licensing and permits, labor relations, risk management including food and beverage issues, safety and security, and liability and negligence.
Prerequisite(s): FIN 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4484 - International Tourism (3 credits)
Survey of global travel and tourism issues, including trends and patterns of global tourism, flow models, constraints and obstacles to international travel, demand for travel and tourism, tourism supply distribution, destination competitiveness, tourist safety and security, international travel and tourism organizations, performance measures. Analysis of sustainable indicators in protected areas and world heritage sites, tourism statistics and trends.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4514 - Hospitality Market Data Analysis (3 credits)
Extraction and analysis of industry data on a selected market for development and presentation of the Market Study in a worldwide competition among other universities. In conjunction with a leading hospitality industry data provider, students have an opportunity to extract and analyze current industry data. Expands teamwork and communication skills through written and oral delivery of the study. Impact Analysis study of a recent current event on hotels, related and non-related travel sectors.
Prerequisite(s): HTM 3524 and HTM 3444 and HTM 4454
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4964 - Field Study in HTM (3 credits)
Prerequisite(s): (HTM 3414 and HTM 3524) or (HTM 3414 and HTM 3444) or (HTM 3254 and HTM 3444)
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Human Development (HD)

HD 1004 - Childhood and Adolescence (3 credits)
Basic concepts related to human development. Emphasis on developmental theories and principles of physical, social, and emotional growth, development, and behavior of children, individually and within families and cultures, from conception through adolescence. Designed as a general survey Course for majors and non-majors.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 1014 - Introduction to Human Development & Family Science First Year Experience (1 credit)
Introduction to the Human Development and Family Science Department: majors, minors, and curriculum requirements and options. Introduction to academic skills and career exploration. Exploration of University programs and services that support students and promote student development.
Instructional Contact Hours: (1 Lec, 1 Crd)

HD 1134 - Introduction to Disabilities Studies (3 credits)
Introduction to concepts related to physical, intellectual, cognitive, and emotional disability, with a focus on disability as a social construct and lived experiences of people with disabilities across the lifespan. Exploration of texts, videos, and other created artifacts to evaluate concepts and models of disability.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 1984C - Special Study (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

HD 2004 - Adulthood and Aging (3 credits)
Introduction to adult development and aging (gerontology). Basic concepts, principles, theories, research methods and social issues of development from emerging adulthood through the end of life. Biopsychosocial analysis of issues affecting aging processes, including family dynamics. Consideration of social, economic, political and ethical issues in aging. Attention to multicultural perspectives and significant global challenges and opportunities related to aging around the world.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2014 - Integrative Practices for Health, Wellbeing, and Resilience (3 credits)
Theories of integrative (mind-body) health and wellbeing. Examination of multidimensional factors, including stress, personality, relationships, and social environment, as well as issues of identity and equity that influence health across the lifespan. Engagement in contemplative and evidence-based integrative health practices used for promoting health, wellbeing, and resilience. Attention given to ethical use and teaching of practice methods.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2104 - Quantitative Approaches to Community Research (3 credits)
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2104

HD 2304 - Family Relationships (3 credits)
Overview of basic concepts, principles, theories, and issues of development and change in family relationships. Topics include families in historical and contextual perspective, structural and relational diversity in families, and processes of relational development, maintenance, and dissolution in families.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2314 - Human Sexuality (3 credits)
Explores the diversity of human sexuality using global perspectives. Biological, historical, developmental, psychological, sociological and self-reflexive approaches. Interdisciplinary examination of the social constructions of sexuality and gender; the historical and contemporary theoretical perspectives and research on sex; the interactions of race, ethnicity, class, gender, sexual orientation, religion, ability, and nationality in shaping sexuality and family formation; the international commercialization of sex; the impact of violence and sexual coercion; the debates surrounding sexual ethics, unintended pregnancy, sex education, and biotechnology; the application of the scientific method, study designs, and methods of observation; the promotion of sexual and reproductive health across the lifespan; and the development of sexual practices, rituals, mythologies, belief systems and other cultural contexts for sexuality across time and around the world.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2335 - Principles of Human Services (3 credits)
2335: Basic concepts, techniques, and structure of the human services profession. Survey of client/family assessment and problem management. 2336: Advanced topics in human services focusing on: case management, crisis intervention, program administration, specialized interventions, ethics, and professional development.
Corequisite(s): 1004 or Pre: 1004.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2336 - Principles of Human Services (3 credits)
2335: Basic concepts, techniques, and structure of the human services profession. Survey of client/family assessment and problem management. 2336: Advanced topics in human services focusing on: case management, crisis intervention, program administration, specialized interventions, ethics, and professional development.
Prerequisite(s): HD 2335
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 3014 - Research Methods in Human Development (3 credits)
Critical thinking and problem-solving involved in applying methods of scientific inquiry to the field of human development and family science. Analysis of individuals, families, and groups. Topics include method of data collection, basic methods for displaying and analyzing data, and writing reports.
Prerequisite(s): HD 2004 and HD 2304 and (STAT 3005 or STAT 3615 or STAT 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3024 - Community Analytics (3 credits)
Application of data analytics concepts to community issues at local and global levels. Data sources, data quality, data representation and data ethics. Statistical analysis to improve community livability. Communication of data and statistics for community stakeholders. Evaluation of reports that use data. Sophomore standing or higher.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3114 - Issues in Aging (3 credits)
Investigates selected contemporary issues and measures potential solutions in adulthood and old age; family and friend relationships; work and retirement; political, legal, and economic issues; vulnerability related to gender.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3144 - Education of Exceptional Learners (3 credits)
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCI 3144

HD 3214 - Infancy and Early Childhood (3 credits)
Theories, principles, and patterns of physical, cognitive, social and emotional development from conception to the early school years. Micro and macro environmental influences on development, including families and culture, are considered as they interact with genetic/biological determinants of development.
Prerequisite(s): HD 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3224 - Middle Childhood and Adolescence (3 credits)
Theories, principles, and patterns of physical, cognitive, social and emotional development from middle childhood to adolescence. Micro and macro environmental influences, including families and culture, on development as they interact with genetic/biological determinants of development.
Prerequisite(s): HD 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3234 - Child/Youth Community Services (3 credits)
Health and human service programs serving children, youth, and families to address life course development issues in the changing American family. Overview of child/youth care issues in areas such as poverty, health and healthcare, day-care services, school-based services, court services, child abuse and neglect, and children in residential settings. Methods of determining service eligibility, needs assessment techniques, translation of client data into a plan for community-based programs and services, and procedures for maintaining quality assurance.
Prerequisite(s): HD 1004 and HD 2304 and HD 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3254 - Curriculum in Early Childhood (3 credits)
Supervised experience in planning and implementing emergent, play-based learning experiences for young children; examination of the role of the teacher; exploration of early childhood curricular design and materials suitable for addressing milestones of child development based on theory and research; utilization of approaches related to sharing child-specific information with families.
Prerequisite(s): HD 1004 and HD 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3304 - Advanced Helping Skills (3 credits)
Helping skills used in human services settings. Case management, evaluating crisis situations, and approaches to individual and family assessment.
Prerequisite(s): HD 2335 and HD 2336
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HUM 3464, SOC 3464, UAP 3464

HD 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

HD 3954 - Study Abroad (1-9 credits)
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)

HD 3954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

HD 3954G - Study Abroad (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

HD 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4304 - Human Services Administration (3 credits)
Issues, functions, and responsibilities involved in developing, implementing, and evaluating family and human services programs.
Prerequisite(s): HD 3234 or HD 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4324 - Advanced Family Relationships (3 credits)
Investigation of challenges, stresses, and crises experienced by diverse, complex families over the life course; protective factors and resilience; coping strategies; prevention and intervention; public policies. Pre: Junior standing.
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4324H - Advanced Family Relationships (3 credits)
Investigation of challenges, stresses, and crises experienced by individuals and families; protective factors and resilience; coping strategies; prevention and intervention; public policies.
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4334 - Perspectives On Addiction and Family Systems (3 credits)
Intra-personal and inter-personal dimensions of compulsive- addictive patterns manifested in the context of the family system. Reciprocal interaction between families and other systems. Junior standing required.
Prerequisite(s): HD 2304 or HD 2314
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4354 - Family, Law, and Public Policy (3 credits)
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families.
Prerequisite(s): HD 1004 and HD 2335 and HD 2336 and HD 2004 and HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4354H - Family, Law, and Public Policy (3 credits)
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families.
Prerequisite(s): HD 1004 and HD 2335 and HD 2336 and HD 2004 and HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4364 - Gender And Family Diversity (3 credits)
Examination of the changing character of individual and family diversity, as related to the intersections among gender, race, class, sexuality, age, and ability. Junior standing required
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4714 - Senior Capstone Seminar (3 credits)
Intensive learning experiences in critical thinking and analysis of human development and family science. Opportunities to demonstrate breadth of learning while developing leadership skills and honing professional competencies. Topics include leadership and team development, problem solving, grant writing, program evaluation, and electronic portfolios. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4964 - Field Study (1-19 credits)
Prerequisite(s): HD 1004 and HD 2004 and HD 2335 and HD 2336
Instructional Contact Hours: Variable credit course

HD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Human Nutrition, Foods, and Exercise (HNFE)

HNFE 1004 - Foods, Nutrition And Exercise (3 credits)
Scientific information applied to current concerns in foods, nutrition and exercise as it affects the nutritional health well-being of humans. I,II
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 1114 - Orientation to HNFE (1 credit)
An introduction to the academic and career planning for students in the Human Nutrition, Foods & Exercise major.
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1214 - Topics in Lifetime Activities (1 credit)
Participation in physical activity, fitness assessment, motor skill development. Awareness and development of the physical, spiritual, emotional, social, and intellectual components of wellness. Application of healthy lifestyle choices for improved quality of life. May be repeated with varying content, for a maximum of 6 credits. Pass/Fail Only
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 6 credit hours

HNFE 1215 - Meraki Living Learning Community, Be Well, Be You (1 credit)
Introduces students in the Meraki Living Learning Community to six dimensions of well-being: purpose, social, financial, community, physical, and emotional. Classroom learning, guided practice, connection to well-being resources, and individual exploration to promote lifelong holistic health and well-being. Personal well-being focused on developing a concept of self, understanding purpose, and learning positive health behaviors to support physical activity, nutrition, mindfulness, and personal finance.
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1216 - Meraki Living Learning Community, Be Well, Be You (1 credit)
Introduces students in the Meraki Living Learning Community to six dimensions of well-being: purpose, social, financial, community, physical, and emotional. Classroom learning, guided practice, and individual exploration to promote lifelong holistic health and well-being. Community well-being focused on mental health initiatives, student leadership, developing and sustaining relationships, and service.
Prerequisite(s): HNFE 1215
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1804 - Principles of Sport Science (3 credits)
Introduction to the principal concepts of improving human physical capacity through sport, exercise training and diet. Emphasis on critical thinking and evidence-based decision making in describing the limits to human performance, responses, adaptations, and health benefits of exercise.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2004 - Professional Dietetics (1 credit)
Introduction to the profession of dietetics with emphasis on competencies, preparation, and responsibilities associated with dietetic practice. Overview of the structure of The American Dietetic Association (ADA) and its relationship to the dietetic professional. Discussion of current professional concerns. II
Corequisite(s): HNFE 2014
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 2014 - Nutrition Across the Life Span (3 credits)
Nutritional requirements and related health concerns of pregnant and lactating women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036.
Prerequisite(s): HNFE 1004
Corequisite(s): CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2014H - Nutrition Across the Life Span (3 credits)
Nutritional requirements and related health concerns of pregnant and lactacting women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036.
Prerequisite(s): HNFE 1004
Corequisite(s): CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2104 - Moving Body, Moving Mind (3 credits)
Methods of working intentionally towards cultivating optimal brain states. Mind/body practices to develop connections between contemporary neuroscience, movement, and meditative practices. Studies in the intersection of consciousness, movement, and thought. Introduction to yoga, meditation, authentic movement, experiential anatomy, and somatic work. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to the practices of intentional embodiment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: DANC 2104

HNFE 2204 - Medical Terminology (3 credits)
Structure, pronunciation, and use of medical terms; anatomical structures and body systems; terms used in pathology, testing, diagnosis, surgery, pharmacology and treatment.
Prerequisite(s): (BIOL 1005 or BIOL 1105 or BIOL 1205H) and (BIOL 1006 or BIOL 1106 or BIOL 1206H) or ISC 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2254 - Exercise Leadership - Group Fitness Instructor (3 credits)
Development of theoretical and practical skills for leading exercise in a group setting. Topics include: general guidelines for instructing safe, effective, and purposeful exercise, essentials of the instructor-participant relationship, the principles of motivation to encourage adherance in the group fitness setting, effective instructor-to-participant communication techniques, methods for enhancing group leadership, and the group fitness instructors professional role. Obtain knowledge of programming for multiple populations. Will complete a CPR and AED certification as a part of in-class instruction. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2264 - Exercise Leadership- Personal Trainer (3 credits)
Development of practical skills for conducting one-on-one exercise sessions for general healthy adults and special populations. Exercise selection, testing, training principles, and behavioral change skills required to be an effective personal trainer. Preparation for a nationally accredited personal training certification. CPR and AED certification. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2274 - Wilderness First Responder (3 credits)
Assessment and treatment of emergencies in remote settings. Anatomy, physiology, and pathophysiology, personal and group safety and hygiene, patient assessment and documentation of treatment for trauma, medical emergencies, environmental emergencies, and long-term care. Team management of medical emergencies in wilderness context, organization and implementation of rescues, decision-making, leadership, judgment, and prevention. Prepares students to successfully complete a national certification exam. Pass/fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2314 - Active Transportation for a Healthy, Sustainable Planet (3 credits)
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 2314

HNFE 2334 - Introduction to Integrative Health (3 credits)
Introduction to the principles of integrative health that promote health and well-being. Examination of the person- centered integrative health treatment methods including holistic stress management, the human spirit, communication, energy healing, elements of meditation, healing environments, Chinese medicine, Ayurvedic medicine, voice work, nutrition, therapeutic massage and bodywork, and healing effects of physical activity. Review of scientific evidence of integrative treatments.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2484 - Evidence-Based Practice in Health Science (1 credit)
Evidence-based practice in the field of health science. Utilization and evaluation of published research in literature. Answers to health and healthcare related questions. Identification of well-defined research questions using current frameworks. Best practices of healthcare policies.
Prerequisite(s): HNFE 1004
Corequisite(s): HNFE 2014
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 2544 - Functional Foods for Health (3 credits)
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2544

HNFE 2664 - Behavioral Theory in Health Promotion (3 credits)
Introduction to behavioral theories used to design, implement and evaluate health promotion programs, and theories underlying health behavior change. Interactions between individuals, physical and social environments, interpersonal, and intrapersonal determinants of health behavior. Epidemiological evidence of benefits of healthful eating and physical activity.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2774 - Topics in HNFE (1-3 credits)
A variable-content course. Explores significant contemporary topics in the areas of nutrition, foods, exercise and health. May be repeated for up to six credits.
Prerequisite(s): HNFE 1004
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

HNFE 2804 - Exercise and Health (3 credits)
Introduction to the foundations of exercise science as applied to healthy living, and the concept of exercise as medicine. Fundamentals of health appraisal, foundations of fitness training principles and prescription; nutrition and energy cost, and application of exercise prescription for disease prevention and treatment.
Prerequisite(s): HNFE 1004 and BMSP 2135
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2824 - Prevention and Care of Athletic Injuries (2 credits)
An introduction to the techniques and principles of athletic training. I,II.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 2954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

HNFE 2984N - Special Study (1-19 credits)
Pathway Concept Area(s): 1F Discourse Foundational
Instructional Contact Hours: Variable credit course

HNFE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 3024 - Science of Food Prep Lab (2 credits)
Application of the principles of food science and food preparation techniques related to health promotion, disease prevention, and disease management. Selection, production, and evaluation of foods and beverages. Emphasis on experimentation illustrating chemical and physical reactions, sensory and physical properties, nutrient manipulation, cooking applications, and functions of foods.
Prerequisite(s): (HNFE 1004 and CHEM 1036) or CHEM 1056 or (ISC 2106 and FST 2014)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 3034 - Methods of Human Health Assessment (2 credits)
Evidence-based practice in areas of human health assessment including: anthropometric measurements, vital signs, body composition, aerobic capacity, muscular strength, energy requirements, and health behaviors. Comparison and analysis of assessment methods.
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and BMSP 2136
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 3114 - Foodservice and Meal Management (4 credits)
Foodservice and meal management for the dietetics professional. Emphasis is placed on understanding food procurement, production, distribution, and marketing in a safe and well managed operation. I
Prerequisite(s): HNFE 3024 or HNFE 2224
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

HNFE 3224 - Communicating with Food (3 credits)
Development of oral and written communication skills to communicate food and nutrition information to diverse populations. II
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and (HNFE 3024 or HNFE 2224)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 3634 - Epidemiologic Concepts of Health and Disease (3 credits)
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied. II.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 3634

HNFE 3804 - Exercise Physiology (3 credits)
Effects of exercise on physiology: neuromuscular, metabolic, cardiopulmonary. Scientific basis of physical training. I
Prerequisite(s): BMSP 2136 and HNFE 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 3824 - Kinesiology (3 credits)
The anatomical and biomechanical basis of human motion, with applications for motor skill acquisition, and development and rehabilitative exercises. I
Prerequisite(s): BMSP 2135 and BMSP 2136
Corequisite(s): PHYS 2205 or PHYS 2305.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4004 - Seminar in HNFE: Writing and Discourse in the Major (3 credits)
Focused review of relevant and current literature in selected areas of food, nutrition and exercise. Develop practical strategies for finding research articles on specific topics utilizing a variety of search tools (e.g., library, on-line search engines, etc.). Develop analytical skills to critically assess the significance of published research data. Develop competence in written and verbal presentation of current research in formats suitable for a scientific or a lay audience.
Prerequisite(s): COMM 2004 or ALCE 3634 and HNFE 2484
Corequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4024 - Emerging Issues in Dietetics (1 credit)
Investigation of emerging dietetics topics including professional development, new technologies, current legislative issues, and promising evidence-based practice strategies. Integration of knowledge from previous courses to support quality dietetics practice will be emphasized.
Prerequisite(s): HNFE 4026
Corequisite(s): HNFE 4125
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 4025 - Metabolic Nutrition (3 credits)
4025: Study of bioenergetics and macronutrients, with emphasis on sources, interrelationships, and factors affecting utilization and metabolism. Emphasis on how carbohydrates, lipids, and proteins are metabolized following a meal, during fasting conditions, and when exercising. How metabolism of carbohydrates, lipids and proteins affects and is effected by metabolic disease such as obesity and diabetes will also be examined. 4026: Study of essential vitamins and minerals and their interaction with body systems, especially as these relate to food, exercise and health. Emphasis on how deficiency, toxicity and genetic conditions affect various organ systems, including bone, skin, digestive, and blood. Historical and regulatory policies, and scientific studies establishing recommended dietary allowances for micronutrients are considered.
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and (BCHM 2024 or BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4026 - Metabolic Nutrition (3 credits)
Prerequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4114 - Food and Nutritional Toxicology (3 credits)
Principles of food and nutritional toxicology with primary emphasis on food components and food toxins including absorption, metabolism and excretion. An overview of types of adverse food reactions including food allergy, food sensitivity, and food intolerance. An overview of U.S. and international lawas and regulation of safety assessment of foods including food additives, dietary supplements, and residues of contaminants, pesticides, and antibiotics. Analysis of food and nutritional toxicity cases in the context of the food system, regulatory policies, and public communication.
Prerequisite(s): BMSP 2136 and BCHM 2024 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4125 - Medical Nutrition Therapy (3 credits)
Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. 4125: Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. 4126: Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states.
Prerequisite(s): HNFE 2004 and HNFE 4026
Corequisite(s): HNFE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4126 - Medical Nutrition Therapy (3 credits)
Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. 4125: Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. 4126: Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states. 4125: I. 4126: II.
Prerequisite(s): HNFE 4125
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4134 - Experiential Approach to Nutritional Therapy (2 credits)
Use of didactic and experiential methods to learn and apply theories of behavior change in diverse nutrition counseling situations. Pre: Instructor approval. I
Prerequisite(s): HNFE 4644
Corequisite(s): HNFE 4125
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4174 - Nutrition and Physical Performance (3 credits)
Nutritional requirements for the wellbeing and optimal performance of athletes. Methods of assessment and modification of diet, performance, and body composition in athletes. Evaluation of dietary ergogenic aids and supplements for performance and body composition.
Prerequisite(s): HNFE 2804
Corequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4224 - Alternative and Complementary Nutrition Therapies (2 credits)
Critical evaluation of health claims, mechanisms of action, and research literature for a wide variety of alternative nutrition therapies used for disease prevention and treatment. Practical application of knowledge through completion of problem-based learning projects.
Prerequisite(s): (BIOL 1005 or BIOL 1105 or BIOL 1205H) and (BIOL 1006 or BIOL 1106 or BIOL 1206H) and (CHEM 1036 or CHEM 1056) or ISC 2106 and HNFE 2484
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4254 - Experimental Foods (2 credits)
Experimental study of the functions of ingredients and factors affecting food quality with emphasis on an independent project.
Prerequisite(s): HNFE 3234
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 4354 - Dietary Supplements and Health (3 credits)
Practical and fundamental aspects of widely used dietary supplements (micronutrients, macronutrients, prebiotics, probiotics, plant extracts, bioactive compounds,). Efficacy and mechanism of dietary and botanical supplements in weight management, health promotion, and disease prevention. Interaction of dietary supplements with gut microbiome. Safety and regulatory considerations of dietary supplements. Project-based learning practice with the integration of literature review, project development, writing, and oral presentation.
Prerequisite(s): (BCHM 2024 or BCHM 3114) and (BMSP 2136 and HNFE 2484)
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4514 - Nutritional Genomics (3 credits)
Interactions between foods and nutrients with genetics, genomic DNA, and gene expression in humans and animals. Genetic variants that affect optimal health, metabolism and nutrition in individuals, as well as inheritance of these variants in individuals, and allele frequencies in populations. Scientific, ethical, and legal considerations of genes and nutrition knowledge, personalized testing, and genetic engineering. Junior standing.
Prerequisite(s): HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4624 - Community Nutrition (3 credits)
The application of nutrition principles to an analysis of current applied nutrition programs and a study of the political and legislative processes affecting the practice of dietetics. I
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and HNFE 4026
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4634 - Socio-Cultural Food Systems (3 credits)
Study of social, cultural, and economic aspects of food systems, using quantitative and qualitative methods to assess nutritional status.
Prerequisite(s): HNFE 1004 and SOC 3004
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

HNFE 4644 - Health Counseling (3 credits)
Roles, responsibilities, legal requirements and scope of the health professional. Interviewing, counseling, education, health promotion and behavior change strategies for diverse populations. Guidance and referral, health assessment, communication skills, and problem-solving. Application of counseling techniques such as goal-setting, ethical practice, cultural competence, evidence-based practice. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4645 - Applications in Nutrition Counseling (2 credits)
4645: Experiential methods to apply theories of behavior change to promote nutrition and health changes. Learn and apply nutrition care process using evidence-based knowledge through providing client-centered counseling to individuals. Understanding of contemporary issues related to behavior change and emerging issues through review of lay and professional literature. 4646: Advance nutrition counseling skills through work with more diverse clients. Learn and apply quality improvement skills to enhance nutrition counseling service. Identify information on emerging issues and apply appropriately in counseling setting.
Prerequisite(s): HNFE 4644
Corequisite(s): HNFE 4125
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4646 - Applications in Nutrition Counseling (2 credits)
Prerequisite(s): HNFE 4645
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4754 - Advanced Human Anatomy and Pathophysiology (3 credits)
Advanced laboratory course in human anatomy and physiology with an emphasis on how pathologic disease states affect human homeostasis. Congenital, genetic, chronic, and common global diseases with recognition and evaluation of causes, risk factors, and impact on body systems. Cadaver prosections will supplement models, specimens, and an advanced anatomy visualization system. Intended for students pursuing graduate education in health sciences.
Prerequisite(s): BMSP 2136 and BMSP 2146
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 4774 - Advanced Contemporary Topics in HNFE (1-3 credits)
A variable-content course. Explores advanced topics in the areas of nutrition, foods, exercise or health using higher- order thinking and problem-solving skills. Qualitatively and quantitatively assess current facts supported by scientific literature, as well as controversial issues with conflicting data. May be repeated for a maximum of six credits. Junior Standing.
Prerequisite(s): HNFE 2014 or HNFE 2014H and HNFE 2484
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

HNFE 4804 - Exercise Metabolism and Disease (3 credits)
Explores the role of exercise in the pathophysiology of human metabolic disease with an emphasis on obesity, diabetes, insulin resistance, and exercise tolerance at whole body, cellular and molecular level dysfunction. In-depth assessment of the prospect of exercise as preventive and therapeutic for treatment of metabolic diseases.
Prerequisite(s): HNFE 4025 and HNFE 2804
Corequisite(s): HNFE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4814 - Advanced Athletic Injuries (2 credits)
Medical documentation and administration. Practical experience in locating, identifying, and evaluating anatomic structures Mechanisms of injury and healing process, testing and evaluation of athletic injuries, treatment and rehabilitation of injury to return to play. Not part of an accredited athletic training program.
Prerequisite(s): HNFE 2824 and HNFE 3804
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 4824 - Advanced Kinesiology (3 credits)
Advanced study of human movement during exercise. Integration of biomechanical, anatomical and neuromuscular concepts in the regulation of joint movement associated with exercise, injury and disease.
Prerequisite(s): HNFE 3824 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4834 - Applications in Clinical Exercise (3 credits)
Supervised experience with the Therapeutic Exercise and Community Health Center. Direct Involvement with rehabilitative and preventive exercise and lifestyle programming for cardio-vascular, musculo-skeletal, and other conditions. Exercise leadership, case management, and daily operations. Included seminars, lab experience, and individual meetings with participants and supervisors, related projects.
Prerequisite(s): HNFE 3874
Instructional Contact Hours: (9 Lab, 3 Crd)

HNFE 4844 - Exercise and Neuromuscular Performance (3 credits)
Functional properties of the neuromuscular system. Emphasis placed on the acute and chronic responses of muscle in exercise, rehabilitation and the factors which determine human performance. Special emphasis on the molecular biological factors responsible for skeletal muscle development and differentiation, as well as adaptation to training and disease states, including activation of signal cascades responsible for the changes in muscle performance.
Prerequisite(s): HNFE 3804 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4854 - Internship in Exercise Science and Health Promotion (1-3 credits)
Capstone internship experience in the fields of exercise science and/or health promotion. The student will be immersed in the day-to-day challenges and responsibilities of a practicing health-fitness professional. The 45 contact hours per credit will involve work experience in some aspect of exercise science and/or health promotion. Senior standing and Exercise and Health Promotion majors only. May be repeated for maximum 3 credits.
Prerequisite(s): HNFE 4834
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

HNFE 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Humanities (HUM)

HUM 1024 - Introductory Humanities: Great Books (3 credits)
An introduction to the humanities through the topic of "Great Books." Students will closely analyze primary canonical texts from the West and from the global south. Political, religious, philosophical, and literary works by important writers and communities from across the globe will be explored to understand the human condition and self-formation. Such engagement with primary texts will be put into the context of larger topics such as class, race, and gender in addition to colonialism, decolonialism, and postcolonial modernity.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: CRIM 1054, RLCL 1054

HUM 1324 - Introductory Humanities: The Modern World (3 credits)
The shifts in thought and values during the nineteenth and twentieth centuries in the global imagination, including issues of commerce, scientific inquiry, industrialization, nationalism, war, labor, gender, class differences, race, and the beginnings of postmodernity. Emphasis on interpretive and analytic skills in terms of reading, discussing, and writing about the interrelationships among the arts, literature, philosophy, history, religion, and science, and their contributions toward shaping the values and aspirations of the age, including global contexts and Asian cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1504 - Introduction to Popular Culture (3 credits)
The development and formation of the category of popular culture. Competing theories and methods for analyzing popular culture. Activities, objects, and ideas included under the rubric of popular culture. Critical thinking about the production of popular culture in relation to race, gender, class, and other forms of human difference.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 1504

HUM 1604 - Introduction to Humanities and the Arts (3 credits)
Explores the written, visual, and performing arts of selected periods and cultures, setting them in the context of their times. Study of these periods linked with overarching questions of cultural encounters, interactions, and negotiations. Introduces principles of each art form as well as the means of appreciation. Students taught methods in researching, writing, and presenting on these art forms.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1704 - Introduction to Appalachian Studies (3 credits)
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 1704

HUM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 1984A - Special Study (3 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 2104 - Oral Traditions and Culture (3 credits)
Examination of the worlds great oral traditions, both ancient and contemporary. Emphasis on performance contexts, relationships among multicultural traditions, including American Indian oral traditions, and the relationships among orality, literacy, technology, media, and culture.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2104

HUM 2204 - The Creative Process (3 credits)
Explores ways in which creativity and design can be understood historically as well as understood and practiced in a classroom setting. Subjects include any or all of the following: theories of creativity; traditions associated with understanding and making several kinds of art; studying artworks from different cultural backgrounds, working with the limitations and possibilities inherent in design projects, and examining how and why they were created; and preparing final creative projects for classroom presentation.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 2404 - Folk Cultures in Appalachia (3 credits)
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 2404

HUM 2504 - Introduction to American Studies (3 credits)
Methodology and tools of American studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2504

HUM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 3034 - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3034

HUM 3034H - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3034H

HUM 3204 - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3204

HUM 3204H - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3204

HUM 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, SOC 3464, UAP 3464

HUM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4104 - Explorations in Advanced Humanities Topics (3 credits)
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature, philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: RLCL 4104

HUM 4124 - Topics in Culture (3 credits)
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the cultural of the nineteen sixties. Course may be repeated with different course content for up to 6 credits. Pre: Junior or Senior standing.
Prerequisite(s): SOC 1004 or SOC 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: SOC 4124

HUM 4414 - Issues in Appalachian Studies (3 credits)
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse.
Prerequisite(s): HUM 1704 or APS 1704
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4414

HUM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Industrial and Systems Engineering (ISE)

ISE 2004 - Introduction to Industrial and Systems Engineering (1 credit)
Introduction to the Industrial and Systems Engineering profession through exposure to problems, principles, and practice. Systems thinking, critical thinking, and contemporary issues in industrial and systems engineering. Introduction to the ISE Department, focusing on faculty and research areas. Importance of ethics and professionalism. Academic planning for the BSISE degree.
Instructional Contact Hours: (1 Lec, 1 Crd)

ISE 2014 - Engineering Economy (2 credits)
Concepts and techniques of analysis for evaluating the value of products/services, projects, and systems in relation to their cost. Economic and cost concepts, calculating economic equivalence, comparison of alternatives, purchase versus lease decisions, financial risk evaluation, cash flow sensitivity analysis, and after-tax analysis.
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 2024 - Probability Foundations for Industrial and Systems Engineers (3 credits)
Introduction to the mathematical foundations of probability theory for industrial engineers. Understanding of probability as a model for real phenomena, with applications of probability in an industrial engineering context. Review of set theory, counting (permutations and combinations), definition of probability axioms, sample spaces, random variables, independence, probability distribution functions, probability mass or density functions, expectations, moment-generating functions, joint and conditional random vectors and distributions, and distributions of functions of random variables, central limit theorem.
Prerequisite(s): MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2034 - Data Management for Industrial and Systems Engineers (3 credits)
Investigation of data modeling, storage, acquisition, and utilization in industrial and systems engineering. Development of effective spreadsheet applications. Design and implementation of relational databases via entity-relationship modeling, relational schema, normalization, and queries. Structured query language (SQL) fundamentals and SQL relational databases. Overview of non-relational databases, Big Data, and Data Analytics. All topics covered within the context of typical industrial and systems engineering problems.
Prerequisite(s): CS 1044 or CS 1064 or CS 1114 or ECE 1574
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2044 - Careers in Industrial and Systems Engineering (1 credit)
Overview of the breadth of careers and professional opportunities in the field of industrial and systems engineering. Technical approaches and solutions, emerging trends, career progression, and leadership aspects of industrial and systems engineering practice. Representation of practice across all areas of industrial and systems engineering as well as across a range of industries.
Instructional Contact Hours: (1 Lec, 1 Crd)

ISE 2214 - Manufacturing Processes Laboratory (1 credit)
Laboratory exercises and experimentation in manufacturing processes. Emphasis on using production machines and equipment to make products using multiple manufacturing processes, coupled with inspection per engineering drawings. Processes include assembly, casting, machining, forming, welding, and non-traditional machining, performed manually and/or via computer programming. Also covers basic shop floor operation and documents used for monitoring and controlling part production.
Instructional Contact Hours: (3 Lab, 1 Crd)

ISE 2404 - Deterministic Operations Research I (3 credits)
Deterministic operations research modeling concepts. Linear programming, integer programming, and non-linear programming modeling, assumptions, algorithms, modeling languages, and modern optimization software. Graphical solution, Simplex tableau method and its graphical interpretation. Branch and bound and branch and cut methods. Duality, sensitivity analysis, and Karush-Kuhn-Tucker (KKT) Optimality Conditions with economic interpretation. Network models (formulations and algorithms) including transportation problems, assignment problems, shortest path problems, maximum flow problems, minimum cost network flow problems, and minimal spanning tree problems.
Prerequisite(s): MATH 1114 or MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2804 - Foundations of Systems Engineering (3 credits)
A systems approach to designing, building, verifying, deploying, operating, and sustaining complex engineered systems. Emergent properties of systems, system lifecycle, and systems engineering as a process driven discipline. Technical management of processes regarding acquisition, contracting, and development. Problem formulation and elicitation of requirements. Creation of system elements: resource components, functions, internal and external interfaces. Introduction to decision analysis and risk management, model-based systems engineering and system architectures.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 3004 - Industrial Cost Control (3 credits)
Introduction to basic accounting concepts and operating characteristics of accounting systems. Principles of financial, cost and activity-based accounting, design of accounting systems, techniques of analysis, and cost control. Emphasis on interpretation of accounting for decision-analysis, including the benefits of limitations of accounting information.
Prerequisite(s): ISE 2014 or ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3034 - Technical Communication for Engineers (3 credits)
Fundamentals of effective technical writing. Structure, presentation, and utility of common engineering documents: laboratory reports, technical reports, proposals, progress reports, and project reports. Practice in writing common engineering documents, both individually and collaboratively. Strategies and practice for effective oral technical presentations, both individually and group-based. Ethical and legal considerations in technical writing and oral technical presentations. All topics covered within the context of typical engineering problems and practice.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3204 - Manufacturing Processes (3 credits)
Survey of manufacturing processes including casting, forming, machining, welding, joining, and nontraditional processes such as electrical-discharge machining. Basic manufacturing materials and their properties, structure of metals, metal deformation and heat treatment. Mathematical modeling of common manufacturing processes; process planning and the effect of plans on cost; impact of product design on manufacturability and assemblability. Recent trends in manufacturing, sustainable manufacturing. Also includes topics in inspection and testing, computer-aided manufacturing, and numerical control.
Prerequisite(s): ENGE 1216 or ENGE 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3214 - Facilities Planning and Logistics (3 credits)
Theory, concepts, and methods for designing and analyzing facilities and material flow in manufacturing, storage, and distribution environments. Topic areas include material handling systems, facility layout, facility location, warehousing, distribution, logistics, and transportation. C- or better in ISE 2014, 2404, and 3414.
Prerequisite(s): ISE 2014 and ISE 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3414 - Probabilistic Operations Research (3 credits)
This course introduces probability models used to investigate the behavior and performance of manufacturing and service systems under conditions of uncertainty. Major topics include probability, conditioning, elementary counting processes, and Markov chains and Markov processes. Emphasis is on the use of these tools to model queues, inventories, process behavior, and equipment reliability. C- or better required in STAT 4105, MATH 2224 or 2204, MATH 2214 or 2214H, and ISE 2004.
Prerequisite(s): ISE 2024 and (MATH 2204 or MATH 2204H or MATH 2406H) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3424 - Discrete-Event Computer Simulation (3 credits)
Analysis and design of work systems through static and dynamic simulation. Topics include an introduction to systems analysis and modeling, simulation optimization, model development and testing, and problem analysis through simulation. C- or better required in ISE 3414 and STAT 4105.
Prerequisite(s): ISE 3414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ISE 3434 - Deterministic Operations Research II (3 credits)
Advanced concepts in deterministic operations research, including theory of complexity, integer programming, advanced linear programming techniques, nonlinear programming, dynamic programming. Covers modeling languages and optimization software for integer programming and nonlinear programming problems. Grade of C- or better required in ISE 2004, 2404 and MATH 2204 or 2224.
Prerequisite(s): ISE 2404 and (MATH 2224 or MATH 2204) and ISE 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3614 - Human Factors Engineering and Ergonomics (3 credits)
Investigation of human factors, ergonomics, and work measurement engineering, with emphasis on a systems approach toward workplace and machine design. Discussion of basic human factors research, discipline-specific ethics, design/evaluation methods for industrial and artificial intelligence (AI) systems including human machine interactions, human information processing, visual and auditory processes, design of display and control, effects of environmental stressors on humans, visualization and sonification of large datasets, human factors role in the design of machine learning and AI applications.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3624 - Industrial Ergonomics (3 credits)
Introduction to ergonomics and work measurement with an emphasis on people at work. Discussion of methods for work measurement, ergonomic assessment, and evaluation, with major topics including productivity and performance, manual materials handling, work-related musculoskeletal disorders, safety, training and legal issues. C- or better required in ISE 3614.
Prerequisite(s): ISE 3614 and ESM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4004 - Theory of Organization (3 credits)
A theory of cooperative behavior in formal organizations, including the structure and elements of formal organizations. The executive process and the nature of executive responsibility also are examined.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4005 - Project Management and Systems Design (2 credits)
Capstone design experience for ISE majors. 4005: Structured systems engineering and project management methods and tools to plan, manage, and execute technical industrial and systems engineering projects. Students work in teams to apply industrial and systems engineering and project management tools to define and analyze a real-world problem and communicate results effectively. 4006: Designing, implementing, and evaluating work system solutions, all via students working in teams. Communication of solutions to various project stakeholders.
Prerequisite(s): ISE 2034 and ISE 2214 and ISE 3034 and ISE 3214 and ISE 3424 and ISE 3624 and ISE 4204
Corequisite(s): ISE 4404
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 4006 - Project Management and Systems Design (2 credits)
Capstone design experience for ISE majors. 4005: Structured systems engineering and project management methods and tools to plan, manage, and execute technical industrial and systems engineering projects. Students work in teams to apply industrial and systems engineering and project management tools to define and analyze a real-world problem and communicate results effectively. 4006: Designing, implementing, and evaluating work system solutions, all via students working in teams. Communication of solutions to various project stakeholders.
Prerequisite(s): ISE 4005
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 4014 - Introduction to Management Systems (3 credits)
Introduction to a systems approach for the design and improvement of management systems used in organizations. Discussion of organizational improvement approaches to improve the design and operation of management systems used in managerial decision-making. Analysis of success and failure of organizational improvement projects. Discussion of performance measurement systems, evaluation, and assessment tools.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4015 - Management Systems Theory, Applications, and Design (3 credits)
Systems approach to management, domains of responsibility, structured and synergistic management tools, management system model, contextual frameworks, information portrayal, automation objectives model, evaluation, shared information processing, information modeling. A management process for definition, measurement, evaluation and control, the organization as an information processor, corporate culture, scoping agreements, schemas and management elements, structured design.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4204 - Production Planning and Inventory Control (3 credits)
Planning and control of operations in both manufacturing and service industries. Management and utilization of resources to support cost effective products and services. Principles, models, and techniques used for production planning and inventory control.
Prerequisite(s): ISE 2404 and ISE 3414 and STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4214 - Lean Manufacturing (3 credits)
Overview of Lean Manufacturing principles, theory, methods, and techniques in modern manufacturing enterprises. Lean philosophy and basic concepts, master production scheduling and production smoothing, assembly line sequencing, setup time reduction, U-shaped line balancing/operation, machine arrangement, kanban, autonomation, and value stream mapping. Investigation and discussion of lean manufacturing case studies. C- or better required in ISE 4204.
Prerequisite(s): ISE 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4264 - Industrial Automation (3 credits)
Survey of various technologies employed in industrial automation, with emphasis on industrial applications of robotics, machine vision and learning, and programmable controllers. Introductory robot motion modeling, investigation into problems in Computer- Aided Design (CAD)/Computer-Aided Manufacturing (CAM) integration. Examination of components commonly employed in automation systems, their aggregation, and related production process design.
Prerequisite(s): ISE 3204 or ISE 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ISE 4304 - Global Issues in Industrial Management (3 credits)
Industrial management topics of current interest explored from a global perspective. Current domestic and international challenges resulting from a global marketplace and the proliferation of information and technology. Industrial management and organizational performance, total quality management, business process re-engineering, leadership, organizational change, role of communication and information, and ethics. Examination and comparison across international boundaries.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4404 - Statistical Quality Control (3 credits)
Application of statistical methods and probability models to the monitoring and control of product quality. Techniques for acceptance sampling by variables and attributes. Shewhart control charts for both mean and range of quality characteristics. Design of experiments and analysis of variance for effective data-generation processes. Motivation behind, and theoretical development and application of, both control charts and design of experiments. Design of effective quality control procedures.
Prerequisite(s): ISE 3414 and STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4414 - Industrial Quality Control (3 credits)
Implementation of statistical quality control techniques in an industrial setting. Development and analysis of cost models for use in the design of optimal quality control plans. Also included are new techniques, advanced quality control models, and an examination of the role of industrial statistics in the overall product quality assurance function. C- or better required in ISE 4404.
Prerequisite(s): ISE 4404
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4424 - Logistics Engineering (3 credits)
Introduction to the key issues in the integrated support of a product or process. Synthesis of topics from earlier studies to provide a cohesive approach to their applications. Logistics engineering provides a survey of product support issues and methods of resolving them within the context of the overall production activity. C- or better required in ISE 3414.
Prerequisite(s): ISE 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4434 - Supply Chain and Operations Engineering (3 credits)
Mathematical models, algorithms, and tools to support the design/redesign and management of supply chain systems. Resiliency, reliability, efficiency, and effectiveness of supply chains; collaboration and coordination among the different decision-makers in supply chains; impact of new developments on supply chain engineering, including the growth of the internet and e-commerce, the need to build suitable and environmentally-friendly supply chains. Mathematical modeling and system-wide optimization of the entire supply chain system under certainty.
Prerequisite(s): ISE 2404 and ISE 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4624 - Physical Work Assessment (3 credits)
Physical ergonomics assessment methods, including cardiorespiratory testing, metabolic energy expenditure and balance, strength, anthropometry, endurance and fatigue, electromyography, biomechanics, thermal stress.
Prerequisite(s): ISE 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4634 - Human Factors in Transportation (3 credits)
Introduction to human factors principles applied to surface transportation for industrial engineers. Understanding of human factors research methods, with applications for safety to the transportation system. Haddon's Matrix, human factors research methods, crash countermeasures, public policy implications, and automated driving systems.
Prerequisite(s): ISE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4644 - Risk and Hazard Control (3 credits)
Introduction to the fields of risk assessment, risk and hazard control, safety management, process safety, and system safety engineering through exposure to problems, principles, and practice. Integrated systems approach to problem solving. Industrial accident and disaster case study analysis and review of contemporary issues. Review of risk analysis and control techniques and overview of global regulations and guidelines for process, industrial, and occupational safety. C- or better required in ISE 3614.
Prerequisite(s): ISE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4654 - Principles of Industrial Hygiene (3 credits)
Introduction to the foundations of the field of Industrial Hygiene, that discipline devoted to the anticipation, recognition, measurement, evaluation, and control of occupational health hazards. Includes biological (e.g. microbial agents, allergens), chemical (e.g. solvents, carcinogens, dusts), and physical (e.g. radiation , temperature) hazards. Overview of control of health hazards, such as personal protective equipment, administrative controls, and engineering controls. Will involve lecture and participatory case-study activities. Will provide ample opportunity for hands-on use of monitoring equipment, protective equipment and controls testing devices.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4804 - System Dynamics Modeling of Industrial Systems (3 credits)
Computer-aided approach to analyze and make better decisions in complex industrial systems. Systems thinking and causal loop modeling of complexity over time. Interconnectivity of industrial systems, production, and service. Stock-flow diagrams. Systems modeling of product development and market adoption. Simulation of dynamic problems arising in complex systems. Systems modeling and simulation-based decision analysis to improve performance in service and manufacturing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ISE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Industrial Design (IDS)

IDS 1114 - Play to Make (3 credits)
Transdisciplinary practice in an inclusive, collaborative environment, through the lens of design, technology and creative expression, to describe and evaluate the convergence between art, technology, and human experience in the arts, sciences, humanities, and engineering. Exploration of play for creation of ideas and artifacts (including, but not restricted to multimedia narratives, learning simulations, immersive/performative experiences, and data exploration). Inclusive collaboration with peers and practicing professionals in diverse fields. Critical consideration of art and design and the impacts on history, society, cultures, individuals, and communities. Collaborative research, design, creation, and exhibition of a transdisciplinary project to identify and address a global challenge.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2015 - Industrial Design Laboratory II (5 credits)
Introduction to the discipline of Industrial Design. Emphasis on form generation, including: design theory, problem solving methodologies, conceptualization of ideas, and aesthetic sensibility. Secondary emphasis on skill development in 2 and 3 dimensions: awareness of materials and manufacturing processes, storyboarding, model making, written documentation of design process, and verbal presentation. IDS 2015 is taught in conjunction with IDS 3224: Topics in Design Competencies: Workshop and IDS 2065: Visual Design.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 7 Lab, 5 Crd)

IDS 2016 - Industrial Design Laboratory II (6 credits)
Introduction to the discipline of Industrial Design. Emphasis on form generation, including: design theory, problem solving methodologies, conceptualization of ideas, and aesthetic sensibility. Secondary emphasis on skill development in 2 and 3 dimensions: awareness of materials and manufacturing processes, storyboarding, model making, written documentation of design process, and verbal presentation. IDS 2015 is taught in conjunction with IDS 3224: Topics in Design Competencies: Workshop and IDS 2065: Visual Design.
Prerequisite(s): IDS 2015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 2034 - Design Visualization (3 credits)
Visual communication, modes of representation techniques, freehand drawings, perspectives, axonometric techniques, computer modeling, and form analysis. Presentation of ideas through rapid sketching and communicating resolved designs through detailed hand drawings. Development of portfolio and skills to choose appropriate methods for tasks.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2044 - Human Factors (3 credits)
This course examines human factors as it informs the design process, and as a tool to maximize the physical and psychological aspects of design toward the establishment of a human centered design. Frameworks of industrial design philosophy, research methods, standards and data, human issues, cultural context, and design outcomes.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2114 - History of Industrial Design (3 credits)
Broad movements in the history of art and industrial design. Application and analysis of art and design elements, principles, and composition techniques. Materials, processes, and innovations in art and design in context of culture, geography, and perspective.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2124 - History of Modern Industrial Designers (3 credits)
Introduction to modern industrial design. Elements, principles, and composition techniques in art and design. Major movements from the 20th-century and how the values, ideals, and styles of designers influence the evolution of design. Comparative study of objects, design theory, and methodologies related to the changes in the profession and global perspectives.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2214 - IDS Studio for Minors (6 credits)
Introduction to the discipline and the critical elements that contribute to the complexity of a work of design. Emphasis on intellectual discipline, skills development, communication of ideas, materials research, and a self-motivated search for critical issues. For registered Industrial Design Minors only.
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 2304 - Computer Aided Industrial Design (3 credits)
An introduction to computer aided two and three- dimensional design and modeling as applied in industrial design using both solid and surface software modeling techniques.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 3015 - Industrial Design Laboratory III (6 credits)
Introduction to systematic processes in design. Introduction and application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods.
Prerequisite(s): IDS 2016
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 3016 - Industrial Design Laboratory III (6 credits)
Introduction to systematic processes in design. Introduction and application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods.
Prerequisite(s): IDS 3015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 3124 - Materials and Processes (3 credits)
Current design processes, materials, manufacturing processes, techniques, and equipment used in the design of products for mass and rapid production. Variety of materials and manufacturing processes available to the industrial designer for mass production impact his/her design process. Emphasis placed on the relationship of processes and equipment, to the environment and the end user. Includes concepts of material science. Practical issues of material selection and application, process selection, and specification.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 3204 - Topics in Professional Development (1-19 credits)
Issues of practicing in an industrial design professional environment: public speaking, portfolio presentation, client/civic engagement (service learning), interdisciplinary teamwork and leadership in the development process of industrial products. Repeatable with instructor permission. Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3224 - Topics in Design Competencies (1-19 credits)
Issues of industrial design competencies and expertise required in a professional design environment, for example: software; model making (both hand making and digital rapid prototyping); workshop (wood, metal and plastics); specialized product design areas (packaging, furniture or exhibit design). Repeatable with instructor permission Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3234 - Topics in Design Theory (1-19 credits)
Issues of industrial design theory required for advancement in a professional design environment, for example: Product Semantics; Design Ethics; EcoDesign/Sustainability; Universal Design. Repeatable with instructor permission. Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3514 - Design Research (3 credits)
The course looks at the question of research and the ongoing exercise of re-definition for designers using examples of current design research corporations.
Prerequisite(s): IDS 2016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

IDS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4015 - Industrial Design Laboratory IV (6 credits)
Detailed analysis, research and application of human factors to the design of equipment, work spaces and environments. Design and construction of full scale, interactive models and spaces. Introduction to group activities. Emphasis on the needs, the production and marketing factors of special populations, such as the elderly and disabled.
Prerequisite(s): IDS 3016
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 4016 - Industrial Design Laboratory IV (6 credits)
Detailed analysis, research and application of human factors to the design of equipment, work spaces and environments. Design and construction of full scale, interactive models and spaces. Introduction to group activities. Emphasis on the needs, the production and marketing factors of special populations, such as the elderly and disabled.
Prerequisite(s): IDS 4015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 4044 - Professional Practice and Entrepreneurship (2 credits)
Focus on assembling multidisciplinary teams to engage in the process of bringing a product to market, building a business around a core competency in design, the structure of a design office, and the development and protections of intellectual property. Pre-requisite: Senior standing or permission of instructor.
Prerequisite(s): IDS 2015
Instructional Contact Hours: (2 Lec, 2 Crd)

IDS 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGE 4094, MGT 4094

IDS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Instructional Design & Tech (EDIT)

EDIT 4614 - Instructional Technology: Audio-visual and Computer Uses (3 credits)
An introductory instructional technology course. Principles and production of audio-visual materials and methods in instruction. Application of microcomputers in instruction, emphasizing computer literacy, programming and evaluation of instructional software. Course in methods of teaching, field teaching experience, or teaching experience required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

EDIT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDIT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Integrated Science (ISC)

ISC 1004 - Integrated Science Curriculum First-Year Experience (2 credits)
Introduction to the different fields of science and mathematics, and academic and career planning for majors that are enrolled in the Integrated Science Curriculum. Discussion of academic plans and university and college requirements. Discussion of academic resources such as the University Library, academic integrity, VT Engage, and Recreation Sports. Resume building for internships, research experiences, and graduate school. Exposure to areas of practice and research, and opportunities for education, training, and employment in fields of interest to students.
Instructional Contact Hours: (2 Lec, 2 Crd)

ISC 1005 - Integrated Scientific Reasoning (3 credits)
Introduction to scientific reasoning in the context of integrated science. Exposure to the scientific process through sample topics that showcase the science involved. Data collection and analysis in physical and life sciences through hands-on lab components integrated into the class. Ethical issues as related to physical and biological systems. 1005: Integrated Science: Water and Life on Earth. 1006: Integrated Science: Forms of Energy.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ISC 1006 - Integrated Scientific Reasoning (3 credits)
Introduction to scientific reasoning in the context of integrated science. Exposure to the scientific process through sample topics that showcase the science involved. Data collection and analysis in physical and life sciences through hands-on lab components integrated into the class. Ethical issues as related to physical and biological systems. 1005: Integrated Science: Water and Life on Earth. 1006: Integrated Science: Forms of Energy.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ISC 1105 - Integrated Science I (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. Application of these principles to large-scale societal problems, including the areas of food, energy, health, water, the environment, and more. 1105: Discrete dynamical systems, differentiation and integration, differential equations, population dynamics, chemical reactions, chemical kinetics, Newtons laws, linear and rotary motion, kinetic and potential energy. 1106: Genetics, evolution, molecular biology, organic chemistry, biochemistry, thermodynamics, gases, heat engines, oscillations.
Corequisite(s): ISC 1115
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 1106 - Integrated Science I (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. Application of these principles to large-scale societal problems, including the areas of food, energy, health, water, the environment, and more. 1105: Discrete dynamical systems, differentiation and integration, differential equations, population dynamics, chemical reactions, chemical kinetics, Newtons laws, linear and rotary motion, kinetic and potential energy. 1106: Genetics, evolution, molecular biology, organic chemistry, biochemistry, thermodynamics, gases, heat engines, oscillations.
Prerequisite(s): ISC 1105
Corequisite(s): ISC 1116
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 1106H - Integrated Science I (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. Application of these principles to large-scale societal problems, including the areas of food, energy, health, water, the environment, and more. 1105: Discrete dynamical systems, differentiation and integration, differential equations, population dynamics, chemical reactions, chemical kinetics, Newtons laws, linear and rotary motion, kinetic and potential energy. 1106: Genetics, evolution, molecular biology, organic chemistry, biochemistry, thermodynamics, gases, heat engines, oscillations.
Prerequisite(s): ISC 1105
Corequisite(s): ISC 1116
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 1115 - Integrated Science Laboratory I (2 credits)
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. Discussion of ethical issues connected to scientific advances. 1115: tools of scientific research, water, ecology, kinetics. 1116: tools of scientific research, environmental chemistry, surfactants, nanomedicine.
Corequisite(s): ISC 1105
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (6 Lab, 2 Crd)

ISC 1116 - Integrated Science Laboratory I (2 credits)
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. Discussion of ethical issues connected to scientific advances. 1115: tools of scientific research, water, ecology, kinetics. 1116: tools of scientific research, environmental chemistry, surfactants, nanomedicine.
Prerequisite(s): ISC 1115
Corequisite(s): ISC 1106
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (6 Lab, 2 Crd)

ISC 2105 - Integrated Science II (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. 2105 Molecular cell biology, metabolism, photosynthesis, membrane transport, quantum theory, spectroscopy, elasticity, waves, fluids, electricity and magnetism, linear algebra, genomics, probability theory. 2106: Gene regulation, signal transduction, development, motility, intramolecular forces, stochastic processes, optics and microscopy, materials science, analytical tools. Restricted to majors in the College of Science. Only by permission of the instructor.
Prerequisite(s): ISC 1106H
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 2106 - Integrated Science II (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. 2105: Molecular cell biology, metabolism, photosynthesis, membrane transport, quantum theory, spectroscopy, elasticity, waves, fluids, electricity and magnetism, linear algebra, genomics, probability theory. 2106: Gene regulation, signal transduction, development, motility, intramolecular forces, stochastic processes, optics and microscopy, materials science, analytical tools. Restricted to majors in the College of Science. Only by permission of the instructor.
Prerequisite(s): ISC 2105
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 2106H - Integrated Science II (6 credits)
Introduction to the fundamental principles of biology, chemistry, physics and mathematics in an integrated environment. 2105: Molecular cell biology, metabolism, photosynthesis, membrane transport, quantum theory, spectroscopy, elasticity, waves, fluids, electricity and magnetism, linear algebra, genomics, probability theory. 2106: Gene regulation, signal transduction, development, motility, intramolecular forces, stochastic processes, optics and microscopy, materials science, analytical tools. Restricted to majors in the College of Science. Only by permission of the instructor.
Prerequisite(s): ISC 2105
Instructional Contact Hours: (6 Lec, 6 Crd)

ISC 2115 - Integrated Science Laboratory II (1 credit)
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. 2115: Tools of Scientific Research, Genomics and Proteomics, Nanoscience, and Electromagnetism. 2116: Tools of Scientific Research, Neuroscience, Optics, and Independent Research Project.
Prerequisite(s): ISC 1116
Corequisite(s): ISC 2105
Instructional Contact Hours: (3 Lab, 1 Crd)

ISC 2116 - Integrated Science Laboratory II (1 credit)
Laboratory component of Integrated Science Curriculum where students conduct project-based interdisciplinary laboratories organized into content modules. 2115: Tools of Scientific Research, Genomics and Proteomics, Nanoscience, and Electromagnetism. 2116: Tools of Scientific Research, Neuroscience, Optics, and Independent Research Project.
Prerequisite(s): ISC 2115
Corequisite(s): ISC 2106
Instructional Contact Hours: (3 Lab, 1 Crd)

ISC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Interior Design (ITDS)

ITDS 1114 - Design Appreciation (3 credits)
Introduction to fundamental design concepts, design methods and the history of design. Examples drawn from architecture, interior design, industrial design, graphic design as well as vernacular craft and design traditions. Key concepts from art, literature and philosophy are discussed in relation to design theory.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 1224 - Introduction to Interior Design (3 credits)
Introduction to the elements and principles of interior design, the discipline and practice of interior design. Case studies from interior design practice. Design thinking, language of design, career paths, contemporary issues, global issues, presentation and drawing techniques and sketchbook preparation.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 2044 - Interior Design I (6 credits)
First in a series of six studios. Foundation level interior design studio. Exploration and development of interior spaces emphasizing spatial volume, human factors, elements and principles of design, and presentation techniques. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 2054 - Interior Design II (6 credits)
Spatial relationships continue as a priority from ITDS 2044 and become more advanced. Programs of required spaces are introduced in design projects along with issues of human behavior and perception and color. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 2044
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 2134 - Materials and Methods in Interior Design (3 credits)
Properties and appropriate use of materials in design and construction of building interiors. Floor, wall, and ceiling materials, and materials used in furnishings and equipment are included. Special attention is given to the health effects and environmental impact of material choices in interior design.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 2224 - Interior Design Graphic Communication (3 credits)
Exploration and development of advanced presentation techniques appropriate for communicating interior design concepts. Special attention is given to utilizing digital media as support for visual and verbal communication.
Prerequisite(s): ITDS 2114
Corequisite(s): ITDS 2144
Instructional Contact Hours: (6 Lab, 3 Crd)

ITDS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 3044 - Interior Design III (6 credits)
Exploration and development of interior spaces emphasizing corporate office use, branding of interior environments, and building system integration. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 2054
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 3054 - Interior Design IV (6 credits)
Design process, space planning and code compliance with advanced understanding of appropriate concepts for integrating furniture, fixtures, equipment, color, and finish materials in design solutions. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 3044
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 3114 - Sustainable Design and Biophilia (3 credits)
Sustainable design concepts and theories. Ethical considerations of biophilia, biomimicry, cradle-to-cradle, and other emerging ways of addressing environmental sustainability. Use of biophilia to guide decision making in the built environment. Use of core green building concepts including water use, energy use, sustainable sites and materials. Review of Green Building standards.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3125 - History of Interiors (3 credits)
Survey of significant developments in the design of interiors, furniture, and materials culture with a focus on western civilization. Style, scale, material culture of each period. Social, economic, technological and political influences on design. Significant designers and craftsmen. 3125: 3000 BC through the 19th century European. Egypt, Greece, Rome, Renaissance, Baroque, Rococo, Neoclassical. 3126: Colonial America through 21st century including Modern design. Bauhaus, DeStijl, Post-War, Post-Modern, Eastern influences.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3126 - History of Interiors (3 credits)
Survey of significant developments in the design of interiors, furniture, and materials culture with a focus on western civilization. Style, scale, material culture of each period. Social, economic, technological and political influences on design. Significant designers and craftsmen. 3125: 3000 BC through the 19th century European. Egypt, Greece, Rome, Renaissance, Baroque, Rococo, Neoclassical. 3126: Colonial America through 21st century including Modern design. Bauhaus, DeStijl, Post-war, Post-Modern, Eastern influences.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3175 - Building Systems for Interior Design (3 credits)
Overview of building systems as they relate to the design of building interiors. 3175: overview of building construction including structural systems and materials, code information and thermal concepts related to building systems. 3176: lighting for buildings, sustainable design guidelines, integration of building systems.
Prerequisite(s): ITDS 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3176 - Building Systems for Interior Design (3 credits)
Overview of building systems as they relate to the design of building interiors. 3175: overview of building construction including structural systems and materials, code information and thermal concepts related to building systems. 3176: lighting for buildings, sustainable design guidelines, integration of building systems.
Prerequisite(s): ITDS 2044 and ITDS 3175
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3184 - Construction Documents for Interior Design (3 credits)
An overview of construction documents: drawings and specifications. Development of a set of construction documents for a small commercial interior.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3954 - Study Abroad-Interior Design (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4044 - Interior Design V (6 credits)
High-level spatial quality and design solution. Exploration and development of interior spaces for a variety of project types. Focus on collaboration and team work. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 3054
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 4054 - Interior Design VI (6 credits)
Senior Thesis studio requiring the integration of research and the design of a self-generated project. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 4044 and ITDS 4224
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 4224 - Design Research for Interiors (3 credits)
Project Programming and Design Research Methods in Interior Design. Evaluate and apply design research. Methods in design research, evidence-based design, and neuroscience.
Corequisite(s): ITDS 4044
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 4554 - Contemporary Interior Design Practice (3 credits)
Study of social, economic, political, and technological issues that influence contemporary interior design practice.
Prerequisite(s): ITDS 3126
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

International Studies (IS)

IS 1004 - Nations and Nationalities (3 credits)
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1004

IS 1024 - Comp Gov & Politics (3 credits)
Government and politics of selected countries outside the United States; nature of politics and government, types of political systems, linkages of people and governments, and current political issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1024

IS 1034 - Introduction to International Studies and Political Science (3 credits)
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing process.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1034

IS 1104 - Introduction to European Studies (3 credits)
Multidisciplinary analysis of core issues and topics in European studies. Current affairs, politics, economics, culture, religions, society and history. Regional and individual country perspectives. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 1114 - Introduction to Transatlantic Studies (3 credits)
Multidisciplinary analysis of core issues and topics in transatlantic studies. Origins and evolution of transatlantic interactions. Historical, political, economic, cultural (including language and literature), civilizational, religious, and societal ties binding Europe and the Americas. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1114

IS 1204 - Topics in Global Dialogues (1 credit)
Examination of the impact of culture in world politics. Topics under examination include: culture and global diversity; culture, identity, and order in world politics; international conflict and intercultural relations. Extensive use of case studies. May be repeated twice with different content for a maximum of three (3) credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours
Course Crosslist: PSCI 1204

IS 2004 - Research and Writing in International Studies (3 credits)
Introduces the research and writing process in the field of International Studies. Addresses topics such as selecting and planning a research project, conceptualizing a research design, gathering and analyzing data, interpreting the results and writing a report. Prioritizes research within a framework of rigorous, well-rounded and thorough practices of research ethics. Emphasizes intercultural and diverse research and practices.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2034, PSCI 2034

IS 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2044, PSCI 2044

IS 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2054, PSCI 2054

IS 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2064, PSCI 2064

IS 2084 - The Evolution of World Order (3 credits)
A historical and comparative study of states systems (i.e, ancient, medieval, modern, and contemporary states system). Emphasis on the globalization of the European states system, its various aspects (political, economic, cultural, religious, civilizational, and technological) and its implications for contemporary world order (i.e., the question of human equality and the impact of colonialism and post-colonialism on the question of social, political and economic justice).
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2084

IS 2104 - Europe Country Analysis (3 credits)
Examination of the politics, economics, culture, society, population patterns, and history of individual European countries. Impact of individual European states' domestic affairs on their respective European sub-regions and Europe as a whole. Analysis of intra-European regional developments. Examination of differing country perspectives on European integration.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2104

IS 2114 - Transatlantic Political Frameworks (3 credits)
Examination of transatlantic political, security and economic institutions, such as the Organization for Economic Cooperation & Development (OECD), the North Atlantic Treaty Organization (NATO), and the Organization for Security & Cooperation in Europe (OSCE). Impact of domestic politics and external policies on the operation of transatlantic institutions. US-European relations and their impact on transatlantic institutions and European security. Bilateral political links between European and North America States (i.e., the UK-US- Canada, and France-Canada) and their impact on transatlantic relations and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2114

IS 2134 - Geography of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2134, PSCI 2134

IS 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2224, PSCI 2224

IS 2474 - Religion and Violence (3 credits)
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2474

IS 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2484, RLCL 2484

IS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 3004 - Professionalism and Careers in Political Science and International Studies (3 credits)
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3004

IS 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3034, PSCI 3034

IS 3044 - The Politics of Internet Governance (3 credits)
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3044

IS 3054 - The Dark Web and Threat Analytics (3 credits)
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3054

IS 3064 - Food Politics (3 credits)
Focuses on how scholars, pundits, citizens, and policymakers think about food on local, national, and global scales. Explores various ways of producing, distributing, and consuming food and how they are implicated in specific organizations of power and possibility. Examines how food, and the discourses surrounding food, help structure understandings of a variety of issues, such as identity, property, labor, gender, race, responsibility, and death.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3064

IS 3104 - Security Studies: Theories and Concepts (3 credits)
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3104

IS 3114 - Global Security (3 credits)
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3114

IS 3115 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3115

IS 3116 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3116

IS 3125 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3125

IS 3126 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 3125 or PSCI 3125
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3126

IS 3134 - Global Conflict and War (3 credits)
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the present and future of war.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3134

IS 3135 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3135

IS 3136 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3136

IS 3144 - Global Governance and Public Policy (3 credits)
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crime. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non- governmental organizations, coalitions and corporations in global public policy-making.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3144

IS 3154 - Topics in Global Public Policies (3 credits)
Examines in depth selected global public policies pertaining to health, energy, environment, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) or (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3154

IS 3164 - Global Trade: Structures and Policies (3 credits)
Focuses on the operations of global trading system and its structure, theories of trade in international political economy, world trading powers and international and regional trade international organizations such as the World Trade Organization (WTO), the European Union (EU), the United States-Mexico-Canada Agreement (USMC), European Union (EU), United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and their policies.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3164

IS 3165 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance - Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3165

IS 3166 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nationa Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance - Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3166

IS 3174 - Monetary Foundations of the World Economy (3 credits)
Focuses on the evolution the operations of global and structure of regional international organizations such as the International Monetary Fund (IMF) and World Bank, the global financial and monetary order. Theories of the global and monetary system in international political economy, the structure of world finance, international financial institutions, the rise of new financial powers in the world economy, central banking, monetary and financial regulation and financial crises and policy responses.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3174

IS 3175 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3175

IS 3176 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3176

IS 3184 - Human Security (3 credits)
Introduces the field of human security and examines the conceptual, theoretical, and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and discusses its future.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3184

IS 3194 - Nuclear Strategy & Politics (3 credits)
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3194

IS 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3344, UAP 3344

IS 3374 - The Politics of Energy (3 credits)
Critical and humanistic perspectives of energy and its global problems. Politics and ethics of fuel extraction, distribution, and consumption across cultures and histories. Energy narratives, discourses, and aesthetics in the formation of political identities. Energy and the rise of modern democracy and global capitalism, with an emphasis on the energy dimensions of climate justice. Pre: Junior Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3374

IS 3384 - Politics of Global and Comparative Migration (3 credits)
Theories and politics of international migration. How policies in destination, transit, and origin countries influence migration. Why governments adopt the migration policies they do. Impacts of global, regional, and national politics and policies on migration among countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3384

IS 3394 - Comparative Politics of Immigrant Inclusion (3 credits)
Theories of citizenship applied across levels of government. Comparative policies for political, social, and military inclusion. Explanations for variations in policies supporting citizenship and inclusion across countries. Explanations for differences among immigrants' political inclusion across countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3394

IS 3514 - Latin American Government and Politics (3 credits)
Introduction to the political systems of Latin American countries, including legislative-executive relations, interest groups, political parties, electoral systems, political violence, and socio-political development.
Prerequisite(s): PSCI 1014H or PSCI 1014 or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3514

IS 3515 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3515

IS 3516 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3516

IS 3524 - Politics of Post-Communist Systems (3 credits)
Institutions, party structures, political economy, elite politics, ethnic conflicts, leadership dynamics, and mass political behavior in Russia and other post-communist political systems.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3524

IS 3534 - African Government and Politics (3 credits)
Survey of major concepts and themes in the study of African politics and development: analyses of the state, political institutions, social forces, democratization, sustainable development, issues of contemporary African politics.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3534

IS 3554 - Comparative Political Economy (3 credits)
Economic policies and collective choice processes of pre-industrial, industrializing, and advanced industrial states; problems and crises of industrial development, economic distribution, and technological transfer in the transition from an agrarian to advanced industrial society.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3554

IS 3574 - Government and Politics of Japan (3 credits)
Introduction to governmental institutions, patterns of political organization and behavior, and key policies of the Japanese political system.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3574

IS 3584 - Governments and Politics of Asia (3 credits)
Introduction to governmental institutions, political behavior, and social and economic policy approaches of China and other selected countries in the Asian region.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3584

IS 3594 - Topics in Middle East Politics and International Relations (3 credits)
Government and politics of Middle Eastern states. Religion, culture and society in the Middle East. Nationalism and Middle East politics. Regional conflicts and regional security. International relations of the Middle East. Great powers and Middle East politics. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1024 or PSCI 1024 or IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3594

IS 3615 - International Relations (3 credits)
Structure and development of the modern international system, theories of international policies, international law; international organizations.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3615

IS 3616 - International Relations (3 credits)
Structure and development of the modern international system; theories of international policies; international law; international organizations.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3616

IS 3624 - Foreign Policy and Diplomacy (3 credits)
Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses type of diplomacy and diplomatic methods.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3624

IS 3625 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President; Congress; press; public; and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Lenninist ideology.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 1024H or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3625

IS 3626 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3626

IS 3634 - Human Rights: Global Issues (3 credits)
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3634

IS 3644 - Religion in the Middle East (3 credits)
Critical issues in religion in the Middle East. Competing methods for analyzing religion in the Middle East. Key concepts relating to religion and inter-religious relations in the Middle East such as minority, majority, tolerance, citizenship, and family law. Critical thinking about the relationship between Islam and other religions with particular reference to Muslim-Jewish and Muslim-Christian relations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARBC 3644, RLCL 3644

IS 3694 - Far-right Violence in the United States (3 credits)
Assessment of theoretical and conceptual foundations to understand the rise of far-right violence in the United States. Identification of causes of radicalization into the far-right. Comparison of case studies of historical and contemporary far-right violence. Evaluation of differences and similarities in historical and contemporary case studies. Appraisal of successful responses to far-right violence.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3694

IS 3704 - National Security Strategy (3 credits)
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3704

IS 3734 - National Security (3 credits)
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3734

IS 3795 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3795

IS 3796 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3796

IS 3804 - European Integration (3 credits)
Analysis of the process of industrial, political, legal, economic, social and cultural integration of states in Europe as a whole or within a European sub-region. History and theories of European integration. Examination of various European organizations whose actions reflect different approaches to and different degrees of integration in Europe.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3804

IS 3814 - The European Union: Institutions and Policies (3 credits)
Evolution, organizational structure, political dynamics, and decision-making mechanisms of the European Union. Major internal and external EU policies such as foreign, security and defense policy, economics, Single Market, and monetary union.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3814

IS 3824 - European Union's Foreign and Security Policy (3 credits)
The European Union (EU) as an actor in the foreign, security and defense policy fields. The external relations of the EU and its role in world affairs. The institutional arrangements of EU external relations and EU activity in policy areas including human rights, peacekeeping, environmental governance, trade, and economic development.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3824

IS 3825 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3825

IS 3826 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3826

IS 3834 - European Security Governance (3 credits)
Structure and function of major European security organizations, such as the North Atlantic Treaty Organization (NATO), the European Union (EU), the Organization for Security and Cooperation in Europe (OSCE), and the Collective Security Treaty Organization (CSTO). In-depth analysis of those organizations' role in the European security architecture. Examination of inter-organizational cooperation in addressing European security issues and conflicts.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3834

IS 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3844, PSCI 3844

IS 3854 - European Political Economy (3 credits)
The European Union's major institutions and policies relating to economic and monetary union and trade. Monetary integration, fiscal and economic policy cooperation, financial integration (including the banking union), the single market and the common commercial policy, the common agricultural policy and the EU's regional policy. The internal structure and organization of the European political economy and the external dimension of Europe and its impact on global economics, ranging from the World Trade Organization to EU enlargement and the Developing World.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3854

IS 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 3874, PSCI 3874

IS 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3884, SOC 3884

IS 3894 - Transatlantic Relations Since 1945 (3 credits)
Analysis of the post- World War II transatlantic relations. Origins and historical context of the transatlantic partnership. Impact of the changing security context and domestic politics on the evolution of transatlantic relations. Causes of tensions and discord between the United States and its European allies and their impact on European security and world order.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3894

IS 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3914, PSCI 3914

IS 3924 - Theories of Transatlantic Relations (3 credits)
Examination of historical, cultural, and civilizational approaches to the study of ties binding Europe and North America. Exploration of the role of identity and national interests in the analysis of transatlantic relations. Investigation of the causes of tensions between the United States and its European allies and the management of these tensions.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3924

IS 3934 - NATO & European Security (3 credits)
Origins and evolution of the North Atlantic Treaty Organization (NATO). Organizational structure, decision and policy-making, missions, and operations. NATO and the European Union's Common Foreign and Security policy (CFSP) and Common Security and Defense Policy (CSDP). Impact of domestic politics and external policies on the operation of NATO and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3934

IS 3944 - International Enrollment (0 credits)
Participation in an approved study abroad program without direct supervision of the Va Tech faculty but with required enrollment in an approved program of study in a foreign university.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944S - International Enroll Special 3 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents three billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944T - International Enroll Special 4 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents four billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944U - International Enroll Special 6 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents six billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4004 - Seminar in International Studies (3 credits)
Interdepartmental seminar to synthesize and articulate basic assumptions, theories, and methods of international studies. Senior standing in IS and instructor consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4014 - International Development (3 credits)
Utilizes development, gender, and social theory to examine the impact of aid programs on communities in the Third World. Analyzes such issues as the impact of development projects in agriculture, natural resources, and employment on the local people, the impact of aid on women; and the policies and administrative structures that direct the world of international development.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4024 - Seminar in Diplomacy and Security (3 credits)
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4024

IS 4034 - Topics in Diplomacy Lab (3 credits)
Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4034

IS 4044 - International Communication (3 credits)
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required or instructor consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 4044

IS 4054 - Seminar in Global Political Economy (3 credits)
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4054

IS 4064 - Seminar in Global Development (3 credits)
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing worlds economic and political trajectories. Utilizes case studies, historical analysis and development economics to better understand the economic and political condition of countries in the developing world. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4064

IS 4074 - The Politics of Cybersecurity (3 credits)
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels.
Prerequisite(s): PSCI 3044 or IS 3044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4074

IS 4104 - Topics in European Studies (3 credits)
Selected issues pertaining to European Studies, such as racism in Europe, European art and society, religion and society in Europe, gender politics, and demographic trends in Europe. May be repeated twice with different content for a maximum of nine (9) credits. Pre: Senior Standing.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4104

IS 4114 - Topics in European Union Policies (3 credits)
Governmental and non-governmental actors in environmental policy, climate, energy, health, agricultural, education, industrial, social or similar policymaking. EU organizational structures and decision-making mechanisms. Public opinion. Analysis of policy results and effectiveness. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

IS 4124 - Topics in European Integration (3 credits)
Research and analysis of selected issues pertaining to European integration. Democracy and European governance. Nationalism and European integration. Impact of fascism and racism on European integration. Integration of refugees and migrants in European societies. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

IS 4134 - Capstone Research Project in European Studies (3 credits)
Independent research project focusing on contemporary Europe. Identifying a topic of inquiry, formulating a research question, conducting a literature review, and preparing a research proposal. Collecting, evaluating and analyzing data, composing a research paper and presenting the research findings. Topics may originate from any discipline contributing to European studies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4144 - Topics in Transatlantic Relations (3 credits)
Research and analysis of selected post World War II political, diplomatic and security issues pertaining to transatlantic relations. Topics under examination include: US-EU relations and European security; the transatlantic partnership and world order; transatlantic politics and the global economic system; causes of the transatlantic divide; British foreign policy, transatlantic relations and European security. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4144

IS 4154 - Topics in Transatlantic Studies (3 credits)
Research and analysis of selected issues pertaining to transatlantic studies. Topics under examination include: religion and the transatlantic world; the political economy of the transatlantic slave trade; and the role of culture, language, and literature in cementing transatlantic ties. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4154

IS 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4174, PSCI 4174

IS 4184 - Capstone Project Transatlantic Studies (3 credits)
Independent research project focusing on issues and topics pertaining to transatlantic studies. Identifying a topic of inquiry, formulating a research question, conducting a literature review, and preparing a research proposal. Collecting, evaluating and analyzing data, composing a research paper and presenting the research findings. Topics may originate from any discipline contributing to transatlantic studies. Pre: Senior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4184

IS 4614 - Senior Seminar in International Relations (3 credits)
Selected topics in international relations, including objectives of national policy; dimensions and components of national power; comparative diplomacy; international conflict and cooperation; instruments of conflict resolution. Topics vary from semester to semester as announced. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3615 or PSCI 3616 or IS 3615 or IS 3616 or PSCI 3625 or PSCI 3626 or PSCI 3734 or IS 3626 or IS 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4614

IS 4714 - Senior Seminar in Policy Analysis (3 credits)
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3724 and PSCI 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4714

IS 4734 - Theories and Practices of International Conflict Management (3 credits)
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role of international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice.
Prerequisite(s): PSCI 3616 or IS 3616
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4734

IS 4735 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PSCI 4735

IS 4736 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PSCI 4736

IS 4744 - Intelligence Analysis Workshop (3 credits)
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4744

IS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Italian (ITAL)

ITAL 1105 - Elementary Italian (3 credits)
Fundamentals of the Italian language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 1106 - Elementary Italian (3 credits)
Fundamentals of the Italian language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Prerequisite(s): ITAL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 1204 - Italian Language and Cultures (1-3 credits)
Fundamentals of the Italian Language with emphasis on developing proficiency in practical language use and cultural competency. Offered off campus. Does not fulfill the University foreign language requirement. Variable credit course.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

ITAL 2105 - Intermediate Italian (3 credits)
Emphasizes comprehension of written and spoken Italian, communication in Italian, literature, and culture of Italy.
Prerequisite(s): ITAL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 2106 - Intermediate Italian (3 credits)
Emphasizes comprehension of written and spoken Italian, communication in Italian, literature, and culture of Italy.
Prerequisite(s): ITAL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ITAL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2984B - Special Study (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

ITAL 3105 - Culture Composition and Conversation (3 credits)
Practice in oral and written communication in Italian on a variety of topics in Italian culture. Progressive and comprehensive review of Italian grammar. Expansion of vocabulary.
Prerequisite(s): ITAL 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3106 - Culture Composition and Conversation (3 credits)
Practice in oral and written communication in Italian on a variety of topics in Italian culture. Progressive and comprehensive review of Italian grammar. Expansion of vocabulary.
Prerequisite(s): ITAL 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3305 - Introduction to Italian Literature in Context (3 credits)
Overview of genres and themes of Italian literature from national unification to the present. Familiarizes students with the socio-historical context necessary to discuss and write critically about this literature. 3305 examines the period from unification until the end of World War II including representations of national identity at the time of unification and beyond, generic experimentalism, resistance and complicity in the Fascist era, social realities during World War II. 3306: examines the period from the end of World War II to the present including retrospective debates about historical eras, economic conditions and political responses, gender politics, the influence of specific historical migrations on literature. Taught in Italian.
Prerequisite(s): ITAL 3105 or ITAL 3106
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3306 - Introduction to Italian Literature in Context (3 credits)
Overview of genres and themes of Italian literature from national unification to the present. Familiarizes students with the socio-historical context necessary to discuss and write critically about this literature. 3305 examines the period from unification until the end of World War II including representations of national identity at the time of unification and beyond, generic experimentalism, resistance and complicity in the Fascist era, social realities during World War II. 3306: examines the period from the end of World War II to the present including retrospective debates about historical eras, economic conditions and political responses, gender politics, the influence of specific historical migrations on literature. Taught in Italian.
Prerequisite(s): ITAL 3105 or ITAL 3106
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3474 - Topics in Italian Cinema (3 credits)
Critical issues in the history of modern and contemporary Italy through cinema, with an emphasis on films produced in Italy that most reflect the nation, its culture and society, and its cinematic trends. Students will discuss and write about the cultural, intellectual, and historical contexts present in Italian cinematic works. Sample topics, depending on the given semester, include organized crime, immigration, the urbanization of Italy, and neorealism. Taught in English. May be repeated, with different content, for a maximum of 6 credit hours.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ITAL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ITAL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Japanese (JPN)

JPN 1105 - Elementary Japanese (3 credits)
Fundamentals of the Japanese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Japanese.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 1106 - Elementary Japanese (3 credits)
Fundamentals of the Japanese language, with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one, but less than three, units of high school Japanese.
Prerequisite(s): JPN 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 1114 - Accelerated Elementary Japanese (6 credits)
Proficiency-oriented approach to Elementary Japanese, designed for learners who wish to progress rapidly through the beginning stages of language learning. Speaking, listening comprehension, reading comprehension, writing, and cultural competency at the JLPT (Japanese Language Proficiency Test) level 4 (ACTFL novice-high). Accelerated version of 1105-1106. Duplicates 1105 and 1106. For students with no prior knowledge of the language.
Instructional Contact Hours: (6 Lec, 6 Crd)

JPN 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 19 credit hours

JPN 2105 - Intermediate Japanese (3 credits)
Emphasizes comprehension of written and spoken Japanese, communication in Japanese; study of some literature and culture of the Japanese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): JPN 1106 or JPN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2106 - Intermediate Japanese (3 credits)
Emphasizes comprehension of written and spoken Japanese, communication in Japanese; study of some literature and culture of the Japanese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): JPN 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2114 - Accelerated Intermediate Japanese (6 credits)
Proficiency-oriented approach to Intermediate Japanese, designed for highly motivated learners who wish to progress rapidly through the intermediate stages of language learning or those with some prior experience in Japanese in need of intensive review. Emphasis on reading, writing, listening, and oral communication, and review of intermediate grammar and vocabulary in guided oral and written assignments in tasks such as jobs (full and part time), holidays, vacations, shopping, and education. Study of authentic materials and cultural artifacts in Japanese. Accelerated version of 2105-2106. Duplicates 2105 and 2106. Not recommended for advanced or native speakers of Japanese.
Prerequisite(s): JPN 1106 or JPN 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

JPN 2744 - From Atom to Akira: Japan's Pop Culture (3 credits)
Analysis of Japanese popular culture through anime (animation), manga (comics), and video games. Introduction of important socio-cultural issues in Japan such as language, ideology, identity, gender, race, class, and nationalism. Exploration of the domestic and global popularity of these mediums and their socio-historical contexts, styles, and characteristics. Fostering of cross-cultural awareness and intercultural understanding by addressing global challenges and opportunities in Japan through popular culture. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 3105 - Advanced Japanese (3 credits)
3105: Practice in communication skills in Japanese both orally and writing, including review of grammar, directed composition and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): JPN 2106 or JPN 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3106 - Advanced Japanese (3 credits)
3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): JPN 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3125 - Japanese for Oral Proficiency (3 credits)
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. 3125: Provides students with the ability to converse in every day Japanese conversation. Focus on everyday conversational skills including life topics, transactions, and Japanese media. Emphasis on appropriate body language and understanding of cultural, political, and religious knowledge. 3126: Provides students with the ability to converse in advanced and complex situations. Focus on formal conversations (honorific, humble, and extra-polite) and business Japanese. Not recommended for native speakers.
Prerequisite(s): JPN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3126 - Japanese for Oral Proficiency (3 credits)
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. 3125: Provides students with the ability to converse in every day Japanese conversation. Focus on everyday conversational skills including life topics, transactions, and Japanese media. Emphasis on appropriate body language and understanding of cultural, political, and religious knowledge. 3126: Provides students with the ability to converse in advanced and complex situations. Focus on formal conversations (honorific, humble, and extra-polite) and business Japanese. Not recommended for native speakers.
Prerequisite(s): JPN 3125
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3304 - Japanese Literature in Translation (3 credits)
Overview of genres, themes, and narrative strategies characteristic of Japanese literature and other cultural artifacts, as well as the various historical and cultural contexts from which they arose. Exploration of themes, such as transience, honor, and community, with a particular focus on change and evolution over time. Assessment of literature and cultural artifacts' rendering of and impact on the construction of Japanese identity, such as race, gender, and sexuality. Creation of cross-cultural awareness by distinguishing the influence of other literary traditions on Japan's literature. Development of intercultural understanding by analyzing common themes in Japanese literature and culture and their implications not just for Japanese life, but also for how they interact with broader global concerns. Taught in English.
Prerequisite(s): ENGL 1106 and ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3474 - Topics in Japanese Cinema (3 credits)
Evaluation of the socio-cultural contexts and perspectives of Japanese cinema, including Japanese cinema's ability both to produce and reproduce socio-cultural contexts like the political, religious, or aesthetic constructs of a particular time period. Explanation of the relationship between those contexts and films, such as the anti-war stance of many pre-WWII directors or the impact of Japan's 1989 financial collapse on cinema. Development of a coherent understanding of Japanese cinema and cinematic techniques through films and literary sources, both primary in translation and secondary. Analysis of intercultural perspectives, such as the influence of American and European films on Japanese cinema and vice-versa, in relation to a student's own cinematic tradition. Comparison of intercultural experiences with broader global concerns, challenges, and opportunities as expressed through Japanese film. Taught in English. Variable content. May be repeated twice with different content for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

JPN 3724 - Modern Japanese Culture and Society (3 credits)
Overview of Japanese society and culture through analysis of Japanese language texts and other cultural artifacts, with an emphasis on modern Japan. Examination of socio-cultural and linguistic factors that have influenced the development of modern Japan and Japanese identity, such as its focus on community, weakened financial clout, growing cultural capital. Exploration of the impact of issues such as aging, work-life balance, globalization, and gender norms that continue to shape modern Japanese society, and relating them to students' lives. Assessment of these issues within regional (Asian) and global contexts. Taught in Japanese.
Prerequisite(s): JPN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4104 - Japanese Advanced Grammar (3 credits)
Advanced Japanese grammar skills. Use of special verbs in honorific, extra-modest, and humble form. Analysis and writing of personal and professional texts. Question formation within larger sentences, naming items, using passive and passive-causative sentences. Development of the ability to read, write, and apply the use of 317 intermediate-level kanji in various contexts.
Prerequisite(s): JPN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Journalism and Mass Communication (JMC)

JMC 1114 - Introduction to Media Production Technology (3 credits)
Introduction to basic technologies necessary for multimedia production. Attention to aesthetics and technical aspects of production technologies, including creation, editing, and organization of content. COURSE FEE $95.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 2034 - Visual News Reporting (3 credits)
News reporting through photography, videography, online outlets, and data visualization. Concepts of visual storytelling. Design and production tools and techniques for visual news and feature stories. News elements and journalism ethics in visual communication. Pre: Sophomore standing.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 2074 - Introduction to Sports Media (3 credits)
Development, concepts, and impact of sports media, including roles and responsibilities of journalists, production staff, and public relations professionals. Considerations of stakeholders behaviors and connections. Study of ethical standards and perspectives, communication in sports organizations, types of media, issues in context, and data analytics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3114 - Video Production: Studio (3 credits)
Producing, directing, and writing live video segments; operating control room and studio equipment including studio camera, video switcher, audio board and the creation of video graphics and written packages.
Prerequisite(s): COMM 2034
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

JMC 3154 - Multimedia Reporting (3 credits)
Multimedia news gathering, news writing, audio/visual storytelling, and news judgment for the print and online media. Consideration of professional strategies and standards for reporters, including legal and ethical issues.
Prerequisite(s): COMM 2024 and COMM 2034
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3174 - Advanced Multimedia Reporting (3 credits)
Multimedia gathering and writing of complex news, features, and documentary; visual content and news judgment for television, print and online media; techniques of broadcast interviewing and on-camera performance. Considerations of legal and ethical issues related to the reporting of complex news.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

JMC 3184 - Media Weather Reporting (3 credits)
Techniques for gathering meteorological, information, reporting weather news, and delivering weather forecasts through print, broadcast and online media. Weather information in disaster response. Ethical uses of weather information in reporting threats to public safety.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3244 - Political Communication (3 credits)
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3244

JMC 3254 - Media and Politics (3 credits)
Explores the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3254

JMC 3284 - Data Journalism (3 credits)
Numeracy and data analysis in news reporting. Data sourcing and visualization in storytelling. Ethical and legal issues in data use. Careers in data journalism.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3304 - Topics in Sports Communication (3 credits)
Study of the theory and practices related to sports communication in fields such as public relations or reporting. Topics may include print, broadcast, and online news; college sports information; social media; crisis management; and media relations. May be repeated once with different course content. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3314 - Sports Journalism (3 credits)
Theory and practice of sports journalism, including strategies for writing and broadcasting sports information. Study of ethics and professional standards. Junior standing required. Fee $95.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3324 - Sports Play-by-Play Reporting (3 credits)
Audio and video play-by-play sports reporting and commentary for broadcast and online media. Game research and preparation techniques. Voice pacing, inflection, delivery, airtime management, and ad-libbing skills. Command and use of game statistics. Ethical issues in sports play-by-play reporting and commentary. COURSE FEE $67.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3334 - Sports as Entertainment (3 credits)
Evolution of print, broadcast, and online sports coverage into a leading form of entertainment in the United States. Economic, political, and cultural influences of sports and sports betting in U.S. society. Sports portrayals, personalities, and scandals in movies, music, radio, and television through U.S. history. Ethical perspectives on sports as entertainment.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3344 - Sports Data Journalism (3 credits)
Game statistics and data analysis in sports reporting. Data visualization in sports storytelling. Data sources, sports performance trends, and predictions. Ethical and legal issues in sports data use.
Prerequisite(s): JMC 3314 and COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4014 - Media Effects (3 credits)
Impact of mass media on individuals and on society; methods for documentation of media effects; research about effects on various demographic groups such as children, elderly, and minorities; effects of advertising; effects of interactive and time shift technologies. Junior standing required.
Prerequisite(s): COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4044 - International Communication (3 credits)
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4044

JMC 4064 - Social Media Analytics (3 credits)
Introduction to analytic techniques for social media platforms. Quantitative and qualitative analytic techniques. Design, implementation, and analysis of experimental and observational studies of how people use and engage with social media platforms and how platforms themselves can be used to drive engagement with content. History and trending topics in social media use. Ethical issues involving social media and big data.
Prerequisite(s): COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4094 - Broadcast Management (3 credits)
Broadcast management procedures; programming; sales and advertising. Senior standing required.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4114 - Photojournalism (3 credits)
Interpretive and creative photography applied to journalism; cameras, films, photography techniques; history of photography as communication; advanced darkroom techniques. Junior standing required.
Prerequisite(s): COMM 2034 and COMM 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4134 - Editorial Writing (3 credits)
Development and function of the editorial page; writing of editorials, reviews, and personal columns; examination of role of letters and syndicated columns and cartoons; problems editorial writers face in their jobs and communities. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4144 - Magazine Writing (3 credits)
The writing of feature material (as opposed to the reporting of hard news), plus detailed examination of several article types from a wide variety of contemporary magazines and newspapers. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4254 - Topics Multimedia Journalism (3 credits)
Selected topics in multimedia journalism; emphasis on critical analysis of issues in journalism, and application of media to disseminate information. May be repeated for credit up to a maximum of 6 credit hours with different content.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

JMC 4264 - Social Media Theory and Practice (3 credits)
Study of social media as a professional communication and media tool. Emphasis on foundations in communication theory and contemporary approaches.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4274 - Broadcasting Performance (3 credits)
Advanced study of on-air performance for broadcasters. Professional behaviors and strategies for developing conversational writing, broadcast style, interviewing, reporting, and anchoring. Fee $95.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4334 - Communication Ethics (3 credits)
Discussion of issues related to professional communication ethics; emphasis on recognizing ethical issues, applying theoretical models and critical thinking skills to ethical issues in multimedia journalism, public relations, and communication studies. Includes research on topics related to communication ethics. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4344 - Free Speech in Cyberspace (3 credits)
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4344H - Free Speech in Cyberspace (3 credits)
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4374 - New Communications Technology (3 credits)
Identify recent trends in the innovation of new communications technologies; storage, transmission, and display systems of mediated communication: optical disc, common carriers, telecommunication-computer linkages, high-definition TV, and virtual reality; information industries and society; markets for new and existing telecommunication services. Junior standing required.
Prerequisite(s): COMM 2084 or COMM 4014 or JMC 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4814 - Digital Newsroom: Online (3 credits)
Production of news content for social networks, mobile applications and web-based content management systems. Preparation of news and feature stories on deadline in a newsroom setting. Collection of information from diverse sources. News judgment. Production requirements for online platforms. Audience engagement. Ethical and legal issues in news reporting. Design/lab studio. COURSE FEE $95.
Prerequisite(s): JMC 3174
Instructional Contact Hours: (5 Lab, 3 Crd)

JMC 4824 - Digital Newsroom: Broadcast (3 credits)
Production of news content for broadcast. Preparation of news and feature stories on deadline in a newsroom setting. Collection of information from diverse sources. News judgment. Videography and digital editing. Broadcast performance. Ethical and legal issues in news reporting. Design lab/studio. $95 COURSE FEE.
Prerequisite(s): JMC 3174
Instructional Contact Hours: (5 Lab, 3 Crd)

JMC 4834 - Sportscenter (3 credits)
Gather, formulate, and deliver sports stories to diverse audiences through print, online, and broadcast channels. Produce sports news on deadline in a newsroom setting. Ethical and legal issues in sports journalism. Design lab/studio. COURSE FEE $95. Pre: Senior standing.
Prerequisite(s): JMC 3314 and JMC 4274 and COMM 2024
Instructional Contact Hours: (5 Lab, 3 Crd)

Judaic Studies (JUD)

JUD 1105 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HEB 1105

JUD 1106 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): JUD 1105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HEB 1106

JUD 2134 - Judaism: A Survey of History, Culture, and Heritage (3 credits)
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2134

JUD 2414 - Hebrew Bible/Old Testament (3 credits)
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the Hebrew Bible (Old Testament).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2414

JUD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 3404 - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament and beyond.
Prerequisite(s): REL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3404

JUD 3404H - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3404H

JUD 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3494, RLCL 3494

JUD 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc.
Prerequisite(s): JUD 2134 or PSCI 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3544, RLCL 3544

JUD 4424 - Advanced Topics in Jewish Culture, History and Thought (3 credits)
Selected topics in Jewish culture, history and thought. Possible topics includes: the philosophy of Maimonides, Spinoza or Buber, or a course dedicated to one of the following topics: Kabbalah, Hasidism, The American Jewish experience in the first half of the 20th century, and Oriental Jewish art and folklore. Two JUD courses or senior standing required. Alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

JUD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Korean (KOR)

KOR 1105 - Elementary Korean (3 credits)
Introduction to speaking, listening, reading, and writing the Korean language. Emphasis on developing proficiency in practical language use, comprehension, and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: Transactions like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)

KOR 1106 - Elementary Korean (3 credits)
Introduction to speaking, listening, reading, and writing the Korean language. Emphasis on developing proficiency in practical language use, comprehension, and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: Transactions like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): KOR 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

Landscape Architecture (LAR)

LAR 1014 - Landscape Architecture Foundation Design Laboratory (6 credits)
Immersive, interactive learning environment, design concept and process development, self and peer assessment. Design studies in two and three dimensions across multiple scales, landscape systems, foundational design theories, principles of spatial design and techniques used to create landscape spaces, systematical exploration and communication of ideas through visual, physical, and oral communications.
Prerequisite(s): ARCH 1015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 1254 - Environment and Natural Systems (3 credits)
Introduction to the environment, natural systems with emphasis on their relationship to urban sustainability and resilience: natural elements, structures, patterns, natural systems, ecology, and landscape ecology. Impact of human actions and decisions on the environment and natural systems from global to local scale. Application of relevant theories and methods related to the environment and natural systems in planning and design.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 1264 - Seeing, Understanding and Representing Landscape and the Built Environment (3 credits)
Exploration of the natural and built environment through observation, interpretation and graphic representation of the landscape. Development of a range of graphic strategies and techniques with an emphasis on design thinking, iteration, and ethical issues expressed in the natural and built environment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2015 - Landscape Architecture Design Studio: Place and Process (6 credits)
Basic theory, principles, and methods of landscape design and site planning. 2015: Design theory involving two and three dimensional compositions. Mass/space relationships, principles of spatial design and techniques used to create landscape space. 2016: Design theory relating to landscape design and site planning. Design of small scale spaces in which the analysis of site, context and the requirements of human use are brought together in a creative synthesis.
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2016 - Landscape Architecture Design Studio: Place and Process (6 credits)
Basic theory, principles, and methods of landscape design and site planning. 2015: Design theory involving two and three dimensional compositions. Mass/space relationships, principles of spatial design and techniques used to create landscape space. 2016: Design theory relating to landscape design and site planning. Design of small scale spaces in which the analysis of site, context and the requirements of human use are brought together in a creative synthesis.
Prerequisite(s): LAR 2015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2025 - Landscape Architecture Design Studio Place, Process and People (6 credits)
Landscape design and site planning including design processes, design communication, community-based design, case study methods, landscape performance. 2025: planning, programming and design of places, analysis of site, context and design for human use, and natural systems in creative design syntheses. 2026: master plan and site-scale planning and design incorporating multiple program elements with emphasis on social, cultural and natural systems infrastructure of neighborhoods and communities. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 1014
Corequisite(s): LAR 2164
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2026 - Landscape Architecture Design Studio Place, Process and People (6 credits)
Landscape design and site planning including design processes, design communication, community-based design, case study methods, landscape performance. 2025: planning, programming and design of places, analysis of site, context and design for human use, and natural systems in creative design syntheses. 2026: master plan and site-scale planning and design incorporating multiple program elements with emphasis on social, cultural and natural systems infrastructure of neighborhoods and communities. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 2025
Corequisite(s): LAR 3154
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2154 - Landscape Architecture History (3 credits)
Historical development of designed landscapes and landscape architecture with emphasis on western and select non-western cultures. Thematic focus on design theories, the social constructions of nature and relationships with land, ideology of landscape, experience of landscape by different social groups and cultures, landscape ethics, and parallels between site and urban design.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2164 - Landform Function and Aesthetics (4 credits)
Design principles and technology related to the creation of landforms for functional, aesthetic, and environmental purposes. Landform grading techniques for integrating soils, water, vegetation, transportation systems, and structures through the design and construction processes. Evaluating landform performance for landscape resilience. Design Lab/ Studio.
Prerequisite(s): LAR 1264
Instructional Contact Hours: (1 Lec, 5 Lab, 4 Crd)

LAR 2254 - Social and Cultural Landscapes (3 credits)
Introduction to experiential and cultural content of designed landscapes. Physiological, functional, and psychological factors that affect experience of the landscape. Study of cultural values, attitudes, and philosophies that have shaped historic and contemporary landscapes.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2554 - Leadership for Global Sustainability (3 credits)
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2554, NR 2554

LAR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 3015 - Intermediate Landscape Design and Construction Documents (6 credits)
Development of intermediate site planning and design knowledge skills. 3015 focuses on site/project scale planning and design with emphasis on greenfield development sites and models of conversation oriented design/development.
Prerequisite(s): LAR 2016
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 3016 - Intermediate Landscape Design and Construction Documents (6 credits)
3016 focuses on site/project scale planning and design involving multiple program elements with a focus on urban and suburban redevelopment and densification. Emphasis is given to the social, cultural and natural systems infrastructure of neighborhoods and communities.
Prerequisite(s): LAR 3015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 3044 - Land Analysis and Site Planning (3 credits)
Concepts, principles, and processes of land analysis and evaluation for physical planning and design. Approaches to spatial problem solving with an emphasis on data collection, evaluation, and synthesis using applicable technologies such as Geographic Information Systems (GIS). Analysis and synthesis of natural and socio-cultural systems at varying scales in the site planning and design process using Geodesign method.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 3154 - Watershed Sensitive Site Design and Construction (4 credits)
Examines soil and water resource issues related to landscape architectural site planning and design. Key topics include watershed sensitive site design, estimation and management of storm water runoff, rainwater conservation, design of open channel conveyances for site planning applications, and erosion and sedimentation control. Prerequisite: LAR 2164 or consent of instructor
Prerequisite(s): LAR 2164
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

LAR 3164 - Design in Detail: Materials, Methods and Assembly (4 credits)
Landscape construction knowledge and practices integrating concepts of design detailing with material selection, sustainable construction methods, and environmental performance. Concepts of landscape performance in material use and human interaction, effects on the built environment, and technical documentation.
Prerequisite(s): LAR 2164
Instructional Contact Hours: (2 Lec, 3 Lab, 4 Crd)

LAR 3264 - People Community and Place (3 credits)
Advanced course focusing on landscape/behavior interactions and implications for the design of outdoor environments at site and community scales for sustainable communities. Systems approach to engage various community design program elements, including social, land use, physical infrastructure, public space, movement, energy, and natural systems, in place-making strategies for diverse populations. Methods of community participation and engagement used in community-based design practices. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4004 - History and Theory of Landscape Architecture II (3 credits)
This course studies theoretical and practical developments in landscape architecture and related arts through investigation and analysis of design theory and philosophy, and built form. Pre: 2004 or permission of instructor.
Prerequisite(s): LAR 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4014 - Design and Construction Documentation (6 credits)
Landscape architectural project-based design and construction documentation. Site design integrating experiential learning, programming, schematic design, design development, construction documentation, construction cost estimation, and technical specifications. Construction principles and practices in preparation of site design and set of construction documents. Community-based principles and practices for site design development. Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C) (1H, 11L, 6C).
Prerequisite(s): LAR 2164 and LAR 3154 and LAR 3164
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4034 - Evolution of the American Landscape (3 credits)
Examine and interpret physical changes in the rural and urban landscapes of the United States as they reflect cultural values; technologic innovations; immigration patterns; the roles of diverse professions over time; changing views of use, conversation and preservation of national resources; and expectations for places of live, work and play using an iterative writing process and reflective course discussions.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4084 - Landscape Design and Planning Studio (3-6 credits)
Advanced design studio addresses current land design and planning issues including global climate change across contexts and spatial scales using complex problem-solving methods of a geodesign framework. Domestic and international precedents, theories, guidelines, and regulations. Development and communication of consensus-based comprehensive plans and designs that address sustainability and resilience issues caused by climate change and others. Use of collaborative community-based design practices. Non-Majors - Lecture (1H, 1C), Lab (6L, 2C). Majors – Course Contact to Credit Hour Structure: Lecture (1H, 1C) Lab (6L, 2C) Design Lab/Studio (5L, 3C). Variable credit course. (1H, 6-11L, 3-6C)
Prerequisite(s): LAR 4014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 6-11 Lab, 3-6 Crd)

LAR 4094 - Senior Project (3-6 credits)
Advanced landscape architectural design capstone course using applied research requiring development of a landscape architecture project selected and completed by the student under the direction of a faculty advisor. Landscape architecture theories and issues; design principles and processes, technological tools and communication strategies to develop and implement a comprehensive design study or independent design project in the context of specific concerns of the built environment. Repeatable for a maximum of 9 credit hours. 3 credit hour course - Lecture (1H, 1C), Lab (6L, 2C). 6 credit hour course - Course Contact to Credit Hour Structure: Lecture (1H, 1C), Lab (6L, 2C), Design Lab/Studio (5L, 3C). Variable credit course. (1H, 6-11L, 3-6C)
Prerequisite(s): LAR 4014 and LAR 4084
Instructional Contact Hours: (1 Lec, 6-11 Lab, 3-6 Crd)
Repeatability: up to 9 credit hours

LAR 4134 - Landscape Representation (3 credits)
2D and 3D hand and digital drawing modes and representational techniques used in landscape design explorations and visual presentations. Study and application of landscape representations. Visual communication of landscapes, landscape change, hydrologic patterns, ecologic processes, and human systems related to design, planning and management of the built environment across geographic and site scales. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

LAR 4154 - Design Studies of the Built Environment (3-6 credits)
Design study of built environment using comparative case studies of relationships between society and culture and the physical and built environments, as seen across scales. Design and use analysis and documentation of elements of the physical environment; exploration of interface between building, people, and landscape systems. Independent case study research project includes on-site field investigations, design research and final documentation of findings. Pre: Junior standing. 3 credit hour course - Design Lab (5L, 3C). 6 credit hour course - Design Lab (9L, 6C) Variable credit. Design Lab/Studio. (5-9L, 3-6C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 5-9 Lab, 3-6 Crd)

LAR 4244 - Professional Practice in Landscape Architecture (3 credits)
Comparative study of career options, professional practice types in landscape architecture including current and future practices. Introduction to firm organizational structure, business models, organizational culture and project management. Review of laws, regulations, contracts, financial and business planning, professional ethics and societal forces impacting design processes and work from project inception to built outcomes. Portfolio and resume development.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4254 - Theories of Landscape Architecture (3 credits)
Critical examination of theories relevant to landscape architectural design and the inter-relationship between theory and practice. Evolution of theory with respect to built works. Overview of concurrent design theories and philosophies in the related arts. Pre-requisite: Senior standing or instructors permission.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4304 - Topics in Landscape Architecture (3 credits)
Topics in landscape architecture history, theory and design methods is an advanced course focusing upon issues facing the professional practice of landscape architecture today. Special emphasis on methods of analysis and interpretation including application of creative techniques, analogous thinking, computer-aided procedures and information handling in landscape architecture design and practice. Pre: 3015 and 3016 or permission of instructor. May be repeated with different content for a maximum of 12 credits.
Prerequisite(s): LAR 3015 and LAR 3016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

LAR 4324 - Landscape Architecture Technology III-Construction Documents (4 credits)
This course provides the link between landscape architectural design and construction documentation. Landscape technology covered in preceding technology courses is combined with information on construction principles and practices in the preparation of landscape architectural construction drawings and technical specifications.
Prerequisite(s): LAR 4244
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

LAR 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, HORT 4554, SPIA 4554

LAR 4705 - Landscape Design and Planning (6 credits)
Theories, methods, techniques, and tools relating to the planning and design of sites, communities, and regional landscapes. 4705: Development of design ability through the study of: two- and three-dimensional design, principles and elements of spatial composition, theories and techniques for planning and design of sites, and design communication techniques. Investigation of natural and man-made physical factors and cultural factors, and human needs. Creative design synthesis. 4706: Evaluation of land resources and the allocation of land uses within large complex sites and regional landscapes. Theories and techniques of site planning and community design. Research of natural, cultural and physical conditions. Application of geographic information systems. Assessment of community development and land planning concepts. Proposing land-use and management strategies at community and regional landscape scales. Identification and application of community-based design practices. Pre: 4705 for 4706. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4706 - Landscape Design and Planning (6 credits)
Theories, methods, techniques, and tools relating to the planning and design of sites, communities, and regional landscapes. 4705: Development of design ability through the study of: two- and three-dimensional design, principles and elements of spatial composition, theories and techniques for planning and design of sites, and design communication techniques. Investigation of natural and man-made physical factors and cultural factors, and human needs. Creative design synthesis. 4706: Evaluation of land resources and the allocation of land uses within large complex sites and regional landscapes. Theories and techniques of site planning and community design. Research of natural, cultural and physical conditions. Application of geographic information systems. Assessment of community development and land planning concepts. Proposing land-use and management strategies at community and regional landscape scales. Identification and application of community-based design practices. Pre: 4705 for 4706. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 4705
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4964 - Field Work (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Latin (LAT)

LAT 1105 - Elementary Latin (3 credits)
Introduction to Latin, for development of reading ability. 1105: Introduction to the basics of the language and short readings of graded difficulty. 1106: Introduction to the basics of the language, continued, with introduction of selected passages from ancient Roman authors for reading, comprehension, and translation.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 1106 - Elementary Latin (3 credits)
Introduction to Latin, for development of reading ability. 1105: Accidence, syntax, and vocabulary, with translation of discrete sentences and short readings of graded difficulty. 1106: Accidence, syntax, and vocabulary continued, with the introduction of selected passages from ancient Roman authors for reading, comprehension, and translation.
Prerequisite(s): LAT 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 2104 - Cicero and Livy (3 credits)
A course in two major Latin prose authors. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2114 - Latin Epic: Vergil and Ovid (3 credits)
A course in two important Latin poets of the Age of Augustus with a view to increasing the students ability to understand and read Latin. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2124 - Latin Lyric: Catullus and Horace (3 credits)
Two important Latin poets of the Late Republic. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1105 and LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2134 - Late Medieval Latin (3 credits)
Post-classical Latin, from Augustine and Boethius through the Middle Ages, Renaissance, and the Modern Age. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1105 and LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

LAT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 3004 - Readings in Latin Literature (3 credits)
A variable content course devoted to the study of major Latin texts not offered in the 2000-level courses. Emphasis is on content, style, and context. May be repeated for credit with different content. Two 2000-level courses in Latin or equivalent proficiency required. Writing Intensive.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 4004 - Directed Studies in Latin Prose Composition (3 credits)
Application of Latin grammar structure to the translation of English into Latin. Original compositions are written in Latin. (Will be offered during the academic year whenever there is sufficient enrollment and available staffing). One 3000-level course in Latin required.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

LAT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Leadership Studies (LDRS)

LDRS 1414 - Citizen Leadership (3 credits)
Language, theories, concepts, and competencies associated with practicing effective leadership and social change and developing intercultural and global awareness.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 1424 - Citizen Leadership Praxis (3 credits)
Application of foundational knowledge of leadership, intercultural and global awareness, the social change model, and socially responsible leadership concepts toward a service-learning project.
Prerequisite(s): LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

LDRS 2014 - Principles of Peer Leadership (3 credits)
Theories and basic principles associated with being a positive influence on fellow students, identification of contemporary college student issues, leadership skills utilized to motivate peers in teamwork-based scenarios, leadership skills associated with human development, ethics, maintaining community, and conflict in decision making. May be repeated once for a maximum of 6 credits.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

LDRS 2964 - Field Study (1-19 credits)
May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

LDRS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 3104 - The Dynamics of Leadership (3 credits)
This course examines advanced leadership theories and leadership effectiveness in todays organizations.
Prerequisite(s): LDRS 1015 or LDRS 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 3304 - Elements of Team Leadership (3 credits)
Develop effectiveness in leading, delegating, and communicating within a team environment. Emphasis on motivation of team members, emotional intelligence, ethical issues, team member dynamics, team management, and effective team processes.
Prerequisite(s): LDRS 1015 or LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4044 - Leadership Studies Capstone (1 credit)
Culmination of comprehensive knowledge gained about leadership and social change throughout a students undergraduate career. Involves reflection on collegiate leadership experiences and coursework in the leadership and social change minor. Results in student development of an electronic portfolio (i.e., ePortfolio). Pre: Senior standing.
Prerequisite(s): LDRS 1015 or LDRS 1414
Instructional Contact Hours: (1 Lec, 1 Crd)

LDRS 4514 - Skills for Nonprofit Organizational Leaders (3 credits)
Skills essential for leading nonprofit organizations. Nonprofit sector, governance, fundraising, financial administration, managing personnel, media communications, strategic planning, and leadership skills. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4964 - Field Study (1-19 credits)
May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

LDRS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4994 - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

LDRS 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Liberal Arts and Human Science (LAHS)

LAHS 1004 - Introduction to Liberal Arts and Human Sciences (1 credit)
Introduction to the College of Liberal Arts and Human Sciences: discover majors, minors, and degree requirements in the College of Liberal Arts and Human Sciences. Introduction to academic skills and career options. Review of policies and procedures for academic planning and success. Review of University programs and services that support students and promote student development.
Instructional Contact Hours: (1 Lec, 1 Crd)

LAHS 1014 - Academic Recovery and Success Strategies (1 credit)
Helps students on academic probation and/or returning from academic suspension to develop academic skills, behaviors and motivation towards success; focuses on the development and application of college-level study skills, personal success strategies, and the use of campus resources that enhance individual student achievement. Credit not applicable to meeting degree requirements.
Instructional Contact Hours: (1 Lec, 1 Crd)

LAHS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 1984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

LAHS 2104 - Introduction to Hip Hop Studies (3 credits)
Interdisciplinary survey and examination of Hip Hop aesthetic and cultural expressions, history, and scholarship and their contexts in the U.S. and globally; including how Hip Hop comments on, responds to and reflects, and mediates intersectional identities, space, place, traditions, and histories of inequity and power in the U.S. and globally. Critical analysis and creation of multimedia texts in response to and synthesizing diverse perspectives in Hip Hop. Opportunities to engage and participate in a variety of campus and community organizations and resources.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2724, HIST 2724, STS 2724

LAHS 2784 - Introduction to Public Interest Technology (3 credits)
Introduces concepts, skills, and problems related to Public Interest Technology, an emerging field of comprehensive approaches to ensure that technology—broadly conceived to encompass digital, genomic, agricultural, financial, and other sectors—works for the benefit of public interest. Focuses on introducing basic concepts and frameworks in Public Interest Technology, including social justice, inclusive design, the politics of design and production, technology policy, and stakeholder identification and participation.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 2974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

LAHS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 2984G - Special Study (3 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 3954G - Study Abroad (3 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4024 - Communicating and Engaging with Science Capstone (3 credits)
Capstone experience in in communicating and engaging with science. Transdisciplinary collaboration cooperating with peers in STEM and non-STEM fields. Engagement—via digital, performative, written, and visual approaches—with audiences with diverse levels of scientific understanding. Discussion of methods for assessing the impact of science communication. Senior standing required.
Prerequisite(s): ENGL 4824 and TA 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 4115 - Tech for Humanity Enabling Capability Studio I (3 credits)
Two-semester experiential learning course sequence, which serves as experiential learning studio course, which serves as culminating capstone experience for the planned Tech for Humanity minor. Immerses students in teams working with stakeholders to identify a sociotechnical problem regarding a technology for which the stakeholder group has less access, awareness, adoption, or benefit compared to the broader population; conduct humanistic and social scientific research to better understand the problem; evaluate different policy and design solutions to the problem and how they contribute to social justice, including enhancing diversity, equity, access, and inclusion; and create a concrete prototype of a solution to the identified problem. LAHS 4115 In the first semester of the two-course sequence, students work with an external stakeholder partner (e.g., business, nonprofit organization, community group, or government) to identify a pressing sociotechnical problem experienced by the partner or its users, customers, or constituents. Students apply humanistic or social/behavioral scientific research methods (e.g., historical documentary analysis and focus group interviews) to better understand the nature and causes of the problem. Students evaluate potential solutions to the problem in light of what they found through their research and the potential for increasing social justice. LAHS 4116 In the second semester, student teams prioritize design and prototyping process, working through difficulties and constraints any potential solution faces, and assessing strengths and weaknesses of proposed solutions in dialogue with their stakeholders. Students prototype potential solutions, whether a technological or process design or proposed policy or legislation, and have their prototype assessed, tested, and critiqued by both the instructor and representatives from the stakeholder group.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 4116 - Tech for Humanity Enabling Capability Studio (3 credits)
Two-semester experiential learning course sequence, which serves as experiential learning studio course, which serves as culminating capstone experience for the planned Tech for Humanity minor. Immerses students in teams working with stakeholders to identify a sociotechnical problem regarding a technology for which the stakeholder group has less access, awareness, adoption, or benefit compared to the broader population; conduct humanistic and social scientific research to better understand the problem; evaluate different policy and design solutions to the problem and how they contribute to social justice, including enhancing diversity, equity, access, and inclusion; and create a concrete prototype of a solution to the identified problem. LAHS 4115 In the first semester of the two-course sequence, students work with an external stakeholder partner (e.g., business, nonprofit organization, community group, or government) to identify a pressing sociotechnical problem experienced by the partner or its users, customers, or constituents. Students apply humanistic or social/behavioral scientific research methods (e.g., historical documentary analysis and focus group interviews) to better understand the nature and causes of the problem. Students evaluate potential solutions to the problem in light of what they found through their research and the potential for increasing social justice. LAHS 4116 In the second semester, student teams prioritize design and prototyping process, working through difficulties and constraints any potential solution faces, and assessing strengths and weaknesses of proposed solutions in dialogue with their stakeholders. Students prototype potential solutions, whether a technological or process design or proposed policy or legislation, and have their prototype assessed, tested, and critiqued by both the instructor and representatives from the stakeholder group.
Prerequisite(s): LAHS 4115
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 4214 - Experiential Learning for Social Impact Capstone (3 credits)
Capstone in displacement studies. Promotes social justice through community engaged research. Work with a research or cultural center on campus or a community organization off campus. Academy of Transdisciplinary Studies advisor approval. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAHS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

LAHS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

LAHS 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Management (MGT)

MGT 1064 - Entrepreneurs Residence Experience (3 credits)
Introduces students in the Innovate Living Learning Community to the various aspects of the entrepreneurial ecosytem at Virginia Tech and familiarizes them with common business terminology in the field. Discover the difference between ideas and entrepreneurial opportunities and relate current business events to topics in the course, including specific entrepreneurial opportunities. Provides weekly opportunities to interact with and learn from visiting entrepreneurs through various methods (i.e. fireside chats, dinners, and speaking events) to enhance learning outside of the classroom and build confidence in engaging with seasoned professionals. Discusses entrepreneurial ideas and current opportunities and applies learning to create and deliver an effective, individual startup concept pitch.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 1104 - Foundations of Business (3 credits)
Introduces students to the free enterprise system and the various business functions, such as management, human resources, marketing, operations, accounting and finance, technology as well as to the different types of business such as manufacturing and service. Analyzes the various business functions to help improve understanding of career interests and opportunities, as well as to provide a basic understanding of how a company operates. Applies learning through a group project in which a micro-business is created and managed.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 1935 - Fundamentals of Cadet Professional Leadership (2 credits)
1935: Foundational course of the Virginia Tech Corps of Cadets Citizen-Leader Program. Explores basic business etiquette and introduces the cadet to concepts of online professional identity, basic career preparation, resume writing, basic interviewing techniques and ways to create a healthy nutrition and physical fitness program. Includes a comprehensive physical fitness laboratory. Membership in the Corps of Cadets is required. 1936: Introduces methodologies for efficient and effective leadership, explores options for multiple career paths, basic business etiquette, opportunity to attend leadership conferences and field trips to local businesses. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1936 - Fundamentals of Cadet Professional Leadership (2 credits)
1935: Foundational course of the Virginia Tech Corps of Cadets Citizen-Leader Program. Explores basic business etiquette and introduces the cadet to concepts of online professional identity, basic career preparation, resume writing, basic interviewing techniques and ways to create a healthy nutrition and physical fitness program. Includes a comprehensive physical fitness laboratory. Membership in the Corps of Cadets is required. 1936: Introduces methodologies for efficient and effective leadership, explores options for multiple career paths, basic business etiquette, opportunity to attend leadership conferences and field trips to local businesses. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1945 - Fundamentals of Cadet Leadership (2 credits)
Foundational course of the Virginia Tech Corps of Cadet Leader Development Program. Explores self-understanding, personality types, active and passive followership, leadership and ethical theories. A laboratory introduces freshmen cadets to academic success strategies. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1946 - Fundamentals of Cadet Leadership (2 credits)
Continued emphasis on self-understanding and followership. Introduces adversarial and positive leadership models, hazing statutes and leadership case studies. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2064 - Foundations of Entrepreneurship (3 credits)
Introduction to the study and practice of entrepreneurship in a human-centered context. Examination of the influence of different cultures, institutions, and global factors and the role of human values, beliefs and behaviors on modes of entrepreneurial action. Application of theories and methods of entrepreneurial opportunity identification within the contexts of human behavior, social institutions and/or patterns of culture to generate ideas for new ventures and application of design-thinking theories and concepts in a field-based, experiential learning project to design, iterate and validate a value proposition and business model for a new venture.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2104 - Careers in Management (1 credit)
Career opportunities associated with the Management major's three options: Human Resource Management (HRM), Management Consulting and Analytics (MCA), and Entrepreneurship, Innovation and Technology (EIT). Analyzes the current job markets and opportunities for these career paths. Creating effective resumes and cover letters and researching and networking with targeted firms. Experience scenarios of informational, behavioral, case interviews, and elevator pitch presentations. Incorporate real life perspective through guest speakers who are industry experts and local field visits. Pre: Sophomore and Junior Management majors and business undecided only. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2114 - Principles of Project Management (3 credits)
Broad and comprehensive overview of project management (PM) with emphasis on its application in organizations. Tools, techniques, and evaluative frameworks that are intended to solve problems and execute organizational strategy. Emphasizes project lifecycle and introduces multiple PM approaches and technologies. Change management evaluation and project manager role in implementing related strategies. Assessment of project financial performance, impact, and risk.
Prerequisite(s): MGT 1064 or MGT 1104
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2204 - Global Business of Pop Culture (3 credits)
Analyze the global business of pop culture through a semester-long case study of a selected pop culture industry. Investigate how social, historical, political, and economic forces shape, and are shaped by, business-decision making at local and global scales. Emphasis on business-decision making by pop culture entities reflecting how they have (or have not) responded over time to changing power dynamics and inequity in the macroenvironment (e.g., reimagined social identities and expectations, accelerated globalization and market access, political unrest, etc.). Use project-based learning to assess past strategic decisions from multiple, intersecting perspectives (e.g., social, historical, political, economic, etc.) and make recommendations about market-based decisions.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2314 - Introduction to International Business (3 credits)
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HTM 2314

MGT 2354 - Teams, Leadership, and Business: Cultivating Excellence (3 credits)
Explores a broad range of concepts and theories important for a basic understanding of team leadership, including organizational behavior, motivation, conflict management, business engagement and stakeholders. Semester-long, service-learning assignment and case analyses to evaluate practical applications of exceptional leadership practices and team skills. Examines different cultures and values found within a team and business and challenges of diversity and inclusion in team settings. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2504 - Sustainable Business Management (3 credits)
Foundational study and practice of sustainability and social issues in a business management context. Uses the emerging environmental, social, and governance (ESG) framework to explore the historical context of sustainability in business, influential ESG stakeholders, business commitments towards "net zero" status, business' role in creating and mitigating environmental impact of greenhouse gas emissions (GHG's), profitability of sustainable businesses, relevant government policy and regulation, ESG measurement and reporting, innovation and competitive advantage, sustainable supply chain management, sustainable business models, embedding sustainability into strategy, and how managers conceptualize and initiate ESG programming.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2614 - Foundations of Management Consulting and Data Analytics (3 credits)
Provides students with a fundamental understanding of management consulting as an industry, the consulting process, and success-factors for providing value-adding consulting services. Examines financial and other key concepts that successful management consultants need to master to provide insight and value to their customers. Provides a comprehensive overview of new and emerging technologies impacting the consulting industry and consulting skills in data analytics, data sense-making and data visualization.
Prerequisite(s): MGT 1104 or MGT 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2935 - Career Planning for Cadets (2 credits)
2935: Cadets in this class learn the basic of business networking, developing presentations, professional mentorship, personal finance, and investments, advanced nutrition and living a healthy lifestyle. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 2936 - Career Planning for Cadets (2 credits)
2936: Cadets in the class learn about careers in public service, leadership through service learning, personal investment strategies, ethical business leadership, explore opportunities for public service, and participate in leadership conference. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 2945 - Small Unit Leadership for Cadets (1 credit)
Prepares cadets for responsibilities as small unit leaders. Builds on the previous years knowledge to focus on skills and knowledge necessary to lead small units. Introduces cadets to the importance of communication, includes basic counseling techniques, disciplinary actions, conflict resolution, cadet regulations and leadership case studies. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2946 - Small Unit Leadership for Cadets (1 credit)
Prepares cadets for organizational leadership. Teaches skills and knowledge necessary to effectively lead a mid- level organization. Includes practical counseling techniques using the cadet counseling form, the leaders toolbox, the cadet disciplinary system, mentor program, and conflict resolution. Includes instruction on the Senior Sergeant Selection Process. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to take management-related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

MGT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

MGT 2984O - Special Study (1-19 credits)
Pathway Concept Area(s): 5F Quant & Comp Thnk Found.
Instructional Contact Hours: Variable credit course

MGT 3064 - Cornerstones of Entrepreneurship and Innovation (3 credits)
Provides a cornerstone foundation for the understanding of entrepreneurship and the business innovation process exposing students to fundamental business concepts applied and integrated in these arenas. An examination of value creation through entrepreneurship and the rudiments of new ventures are provided helping students develop an entrepreneurial frame of mind and perspective. Pre: Completion of 45 credit hours and two CLE Area 5 courses.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3074 - Social Entrepreneurship (3 credits)
Provides a foundation for how social entrepreneurs use and combine resources to pursue opportunities that lead to social change and/or address social needs. An examination of the nature of social entrepreneurship and its various practices is provided, helping students develop an entrepreneurial frame of mind and prepare them to act as effective leaders of social change.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3084 - Digital Entrepreneurship, Innovation, and Product Development (3 credits)
Technology-based and digital entrepreneurship in startups, corporate, and public-sector organizations. Course activities in commercialization and resource mobilization strategies for the development of new digital technologies. Data-driven assessment and pursuit of entrepreneurial opportunities in digital environments, including cybersecurity, artificial intelligence, blockchain technologies, biotechnology, and other emerging new technologies.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3094 - Global Entrepreneurship (3 credits)
Global entrepreneurship and venture creation strategies in intercultural global perspectives. Identifies the global entrepreneurial core competencies, applies formal global thinking concepts, and uses integrative problem-solving tools in global entrepreneurial opportunity contexts. Analyze the value proposition of a new venture model across national boundaries. Builds framework for understanding the entrepreneurial process in global contexts. Blends theory with practical experiences in global business contexts to explore and research global entrepreneurial process and environment.
Prerequisite(s): MGT 2064
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3304 - Management Theory and Leadership Practice (3 credits)
Introduces the student to a broad range of concepts, theories and practices important for a basic understanding of management. Includes the functions of management, roles of managers in organizations, and tools and techniques for managing organizational performance. Focus on the global environment in which today's managers must effectively and ethically lead organizations. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3324 - Organization Behavior (3 credits)
This course examines the determinants and consequences of human behavior in formal organizations. Specific focus is on the individual, interpersonal, and group processes which underlie all the human dynamics.
Corequisite(s): 3304 or 3404.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3334 - Managing Human Resources (3 credits)
Examines the strategies, policies, and practices associated with effectively managing human resources. Designed to provide future managers with tools and techniques to acquire, develop, reward, and retain employees within the legal and social context of todays organizations. Emphasizes how managing human resources can contribute to organizational effectiveness in a variety of industrial and organizational settings.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3344 - Employee & Labor Relations Law, Bargaining, and Dispute Resolution (3 credits)
Historical, legal, social, and economic forces that shape employment relationships in the U.S. Labor and employment laws and how they apply in specific cases. Anticipate and respond to a union organizing campaign. Employment contract bargaining and dispute resolution in union and nonunion settings. Compare U.S. private sector, public sector, and international employee and labor relations laws and institutions. Debate contemporary employee relations' events and issues using critical thinking and ethical reasoning.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3404 - Principles of Management (3 credits)
Management concepts, theories, and practices for the effective and successful operation of modern organizations. Four functions of management and the activities involved in each function. Importance of ethical management practices in the effective operation of global business organizations, including entrepreneurial ventures. Individuals and group behaviors in the workplace, as well as methods to improve workplace performance.Duplicates some material in MGT 3304. Course credit will not be awarded for both MGT 3304 and MGT 3404.
Prerequisite(s): MGT 1104 or MGT 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3414 - Talent and Organizational Development (3 credits)
Talent development systems and their strategic support of organizational learning, performance management process, a high-performing workforce, and organizational success. Foundational elements of talent development, including performance management process equity in evaluation and interviews. Emerging talent and organizational development trends and technologies. Talent development and performance management analytics to identify organizational talent capacity to meet current and future workplace needs. Organizational and talent development learning plans within talent-centered cultures in diverse organizational contexts. Emerging issues in learning, performance management, and talent development. Client projects, guest speakers from the field, and contemporary case studies.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3424 - Strategic Talent Planning, Acquisition, and Analytics (3 credits)
Strategic talent planning, acquisition, and analytics within organizations. Alignment of talent planning and acquisition strategies with legal and social contexts, organizational goals, equity, and firm performance. Identification and analysis of key human capital data to inform talent acquisition decisions. Impact of talent planning decisions on acquisition and selection decisions, job design, internal workforce mobility, retention and succession planning for immediate and long-term outcomes. Emerging trends impacting field of human resources and specific to these topics.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3444 - Multicultural Diversity in Organizations (3 credits)
Evaluates the impact of multicultural diversity on the employees work experience and on organizational processes/ performance. Students analyze and discuss theories and practices related to the business case for diversity, exploring the processes through which multicultural diversity (both domestic and international) affects the organization and its stakeholders. Topics include multicultural diversity theories, legislation, interpersonal and international differences, cultural intelligence, and organizational practices. Pre: Junior Standing. (3H,3C)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3604 - Managerial Analytics (3 credits)
Digital tools to analyze managerial data ranging from productivity data to large scale, organizational databases. Three themes: (1) analyzing and improving productivity using digital tools; (2) applying exploratory data tools; (3) improving organizational collaboration, analysis, and knowledge sharing using relational databases.
Corequisite(s): 3304 or 3404.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3614 - Strategy and Competition Analytics (3 credits)
Develops concepts and techniques for analyzing and formulating strategy in a variety of business environments. Focuses on research, data, and analysis related to the key players in the environment from both a competitive and cooperative perspective. Basic frameworks for analysis include mapping the objectives and constraints of the players, and modeling the pattern of interaction among the players. Provides an in-depth exposure to the theory and tools of strategy analysis and practice in their management consulting application.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3754 - Management Internships and Career Development (3 credits)
Guided experience in work environments and job search. Through unpaid internships, students have the opportunity to view the inner workings of businesses first hand while working on organizationally meaningful assignments. Class activities prepare students for conducting effective job searches.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MGT 3804 - Topics for Cadet Global Leadership Studies (3 credits)
Analyzes historic and current leadership challenges using specific military campaigns for context. Covers national and military objectives and various instruments of national power in relation to national security. Travel to relevant country and battlefields for experiential learning. May be repeated with different content for a maximum of six (6) credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

MGT 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3874, PSCI 3874

MGT 3935 - Advanced Professional Development for Cadets (2 credits)
3935: Cadets in this learn about the mentor-protege relationship; resolving team conflicts; diversity in the workplace; standards of business conduct, dining etiquette; and maintaining a healthy lifestyle. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 3936 - Advanced Professional Development for Cadets (2 credits)
3936: Cadets in the class learn about business challenges from panels of experts in various career fields, business problem solving, speaking before a business audience, business writing, preparing for an internship and participation in a leadership conference. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 3945 - Cadet Organizational Leadership (1 credit)
Prepares junior class cadets for responsibilities as senior sergeants. Builds on the previous years knowledge of small unit leadership. Introduces cadets to decision making, writing decision papers/executive summaries, project management, public speaking, and refinement of their personal leadership philosophy. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 3946 - Cadet Organizational Leadership (1 credit)
Prepares junior calss cadets for the role of responsibility they will assume as senior leaders in the Corps. Continues focus on organizational leadership and introduces cadets to command and a commanders responsibilities. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4064 - Developing Entrepreneurial Ventures (3 credits)
Takes a cross-functional perspective on identifying and evaluating entrepreneurial opportunities, developing new ventures, and pursuing new venture strategies to compete in the marketplace. Explores business potentials of new venture ideas, examines new ventures feasibility, and develops business planning tools for the venture. Pre: Senior Standing.
Prerequisite(s): MGT 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4084 - Management Consulting (3 credits)
Hands-on application of accounting, finance, marketing, management, information technology, and project management to actual business clients through on-site consultation with start-up and existing businesses and non-profits. Through classroom instruction, instructor coaching, and experiential studies, students will use the skills they have learned over several semesters to explore the field of management consulting. For the Management major with senior standing in the Management Consulting Option.
Prerequisite(s): MGT 3304 or MGT 3404 and MGT 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGE 4094, IDS 4094

MGT 4314 - International Management (3 credits)
The course is designed to provide the student with familiarity concerning the unique problems, characteristics, and demands that face multinational managers and the international business community. Junior standing required.
Prerequisite(s): MGT 2314 or HTM 2314
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4324 - Business and Professional Ethics (3 credits)
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 4324

MGT 4334 - Ethical Leadership and Corporate Social Responsibility (3 credits)
Focus on the leadership role of managers in promoting ethics and corporate social responsibility in business today. Consideration of the overall role of business in society and specific business-society issues such as equity and identity at work, environmental pollution, consumer and employee concerns, corporate-community relations, and the activities of multinational corporations. Issues examined through conceptual frameworks of business ethics, corporate social responsibility, and leadership (especially servant leadership). Emphasis placed on students articulating analysis of such issues through written and oral communication.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4344 - Productivity and Quality Leadership (3 credits)
This course provides an introduction to leadership in the context of productivity and quality improvement. It focuses on understanding the concepts and skills associated with contemporary management strategies and systems. This course requires active student involvement and emphasizes participative leadership skills, data collection, qualitative problem solving, and communication processes. For Management majors only. Senior standing required.
Prerequisite(s): MGT 3304 or MGT 3404 and MGT 3324 and MGT 3604 and BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4354 - Leadership: Advances in Skills and Concepts (3 credits)
This cornerstone course provides cutting-edge experiences, skills, and knowledge in leadership for students in the leadership minor. Within an historical context that balances military, political, and business perspectives, four types of leadership will be examined: self-leadership, dyadic leadership, team leadership, and enterprise leadership. Special emphasis will be placed on the specific skills, such as computer literacy and project management, required for leaders to succeed in modern, technologically oriented organizations. Pre: Senior standing.
Prerequisite(s): MGT 2354 or MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4394 - Strategic Management (3 credits)
Senior-level capstone course to formulate and implement strategies to create and sustain competitive advantage. Emphasis on developing pragmatic and action-oriented general management skills that integrate across functional areas of the organization. Utilize various tools, concepts, and analytical framework to define and analyze strategic problems. Revisits business principles and practices covered in basic business courses. Pre: Senior standing.
Prerequisite(s): (MGT 3304 or MGT 3404) and (MKTG 3104 or MKTG 3104H) and FIN 3104 and BIT 3414
Corequisite(s): FIN 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4414 - Strategic Compensation, Benefits, and Rewards (3 credits)
Strategic perspective on how decisions about employee compensation, benefits, and rewards help firms to implement business strategy and achieve competitive advantage. Basic compensation tools and analytic techniques used to design an internally aligned and externally competitive pay system in organizations. Individual and group level performance-based rewards that drive performance and achieve business objectives. Strategic choice of employee benefits aligned with organizational goals. Compensation-related laws and analysis of compensation data to ensure equity and legal compliance.
Prerequisite(s): MGT 3334 or MGT 3344 or MGT 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4854 - Analytics in Action (3 credits)
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations.
Corequisite(s): BDS 2005, CMDA 2014
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4854

MGT 4935 - Cadet Citizen Leader Practicum (2 credits)
4935:Students in the class learn practical strategies for leading teams to plan execute a project; project writing; applied dining etiquette; being a mentor to others, leadership through service learning and living a healthy lifestyle. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 4936 - Cadet Citizen Leader Practicum (2 credits)
4936: Students in the class begin the process of transition from college to their intended career. Topics include conduct of effective meetings, salary and benefits negotiation, obtaining post-graduation professional development, serving as a mentor, and developing a plan for the first six months in a new job. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 4944 - Leading in Your Profession (1 credit)
Examines the skills and knowledge necessary to succeed in a responsible role of leadership when beginning ones career. It is a capstone course that draws on the leadership training and experience cadets have accumulated during their first three years in the Corps of Cadets. Senior standing in the Corps of Cadets required. Course may be taken twice for credit. The pre-requisite requirement is such that a student must take the pre-requisite twice before enrolling in this course.
Prerequisite(s): MGT 2944
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

MGT 4945 - Executive Leadership for Cadets (1 credit)
Examines executive level leadership. It explores executive decision making, constraint theory and problem solving in both the military and civilian career fields. Senior standing in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 4946 - Executive Leadership for Cadets (1 credit)
Prepares senior class cadets for the transition from college to career professional. Explores life planning, personal finance, taking charge in a new organization, cross- generational communication, and developing subordinate relationships. Senior standing in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4994H - Undergraduate Research (1-19 credits)
Honors section
Instructional Contact Hours: Variable credit course

Marketing (MKTG)

MKTG 2104 - Careers in Marketing (1 credit)
Provide students with an early start on understanding the many career options within the marketing major. In-depth focus in developing an online professional branded website and career map. Enhance and broaden the understanding of customer's needs, while gaining the sense of ownership over the product and/or service to meet customer's needs through communication of marketing strategy. Serves as a foundational course in preparing students for career success in the Marketing field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

MKTG 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop marketing-related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

MKTG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 2964H - Field Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MKTG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 2994 - Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 3104 - Marketing Management (3 credits)
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3104H - Marketing Management (3 credits)
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3134 - Personal Well-being and Professional Success (3 credits)
In-depth study of the science of well-being and stress management for business and business professionals from multi-disciplinary perspective (Positive Psychology, Consumer Research, Behavioral Economics, Neuroscience, Sociology). Includes relevance of well-being data in marketing and business contexts. Application of well-being and stress management strategies to overcome wellbeing barriers, ensure work-life balance and create positive work environments. Exploration of policy implications of well-being data.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3164 - Introduction to Digital Marketing Strategy (3 credits)
Study of the principles of digital marketing and its applications. Integration of digital strategies with overall business and traditional marketing plans. Emphasis given to critical digital knowledge in inbound marketing, identifying and creating buyer personas, email marketing, search engine optimization, planning and executing digital content marketing calendars, social media marketing, web analytics and digital compliance legislation and regulations, and their ramifications.
Corequisite(s): 3104 or 3104H.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3504 - Advertising (3 credits)
Survey of advertising principles and its applications. The course covers advertising history, the impact of advertising on society, and ethical and regulatory issues. The process of creating and placing advertising is explored including advertising objectives, budgeting, media planning and mix, creative objectives and strategy, copy execution and production, and copy testing. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4054 - Sales Technology (3 credits)
Course focus is on the integration of technology and data analytics to advance sales. Study of how technology is leveraged in the social sales process which includes how to successfully utilize technology in social selling situations. Emphasis given to Customer Relationship Management (CRM) strategies, benefits, operations, and application across the customer life cycle. Students demonstrate proficiency in CRM technology, through experiential learning by earning Salesforce, Hubspot and Smartfox badges.
Prerequisite(s): MKTG 3104
Corequisite(s): MKTG 4554
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4114 - Introduction to AI in Marketing (3 credits)
Study Artificial Intelligence (AI) and machine learning concepts, myths vs. facts, and barriers associated with AI. Explore the need and uses of AI in marketing and sales. Includes strategies for firms to identify AI opportunities, and the pitfalls and barriers associated with AI implementation. Consider how to implement AI, measure AI success, and gain competitive advantage through AI. Analyze the consumer, firm, and societal impacts of AI from marketing and ethics perspectives, and suggest corrective strategies for firms. Pre: Junior standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4144 - Business and Marketing Strategies for the Process Industries (3 credits)
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4144

MKTG 4154 - Marketing Research (3 credits)
This course is a study of the scientific process of problem solving in a marketing context. It includes concepts of problem definition, hypotheses generation, questionnaire development, research design, implementation, analysis, and interpretation of statistical findings. Junior standing required.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604) and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4164 - Social Media and Content Marketing (3 credits)
Study of social media channels and content creation processes and strategies. Integration of inbound marketing methodologies with social and digital media marketing. Emphasis given to content marketing distribution strategies, influencer marketing, social media advertising, and key content marketing tools including blogs, vlogs, and podcasts, as well as employee advocacy programs and social media and crisis management plans for organizations.
Prerequisite(s): MKTG 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4174 - Analytics & Metrics for Digital Marketing Strategy (3 credits)
Study of the assessment of digital marketing analytics and metrics and their applications. Optimization of digital marketing results across all digital marketing strategies and tactics. Emphasis given to digital marketing measurement models, data-driven decision making including application of the decision-making framework, predictive analytics and data visualizations, website analytics, organic search analytics, social media metrics, email marketing metrics, as well as paid, owned and earned media analytics.
Prerequisite(s): MKTG 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4204 - Consumer Behavior (3 credits)
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4204H - Consumer Behavior (3 credits)
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required. Honors section
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4254 - Product and Price Management (3 credits)
Emphasis on strategic branding and product planning within the context of marketing management. Analysis of economic, financial, legal, and marketing principles to make effective pricing decisions. Examination of relationships between product and price management. Junior standing.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4264 - Analytics for Marketing (3 credits)
Integrates conceptual and quantitative aspects of marketing. Provides concentrated emphasis on the role of analytical and computer models to enhance marketing decision making. Emphasis on managerial decision making in key areas, including segmentation and targeting, positioning, forecasting, new product design, forecasting and pricing. Role of consumer perceptions and behaviors on decision making. Hands-on experience with model building and using analytical tools.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4304 - Marketing Communications (3 credits)
Theory and application of an organizations marketing communications function. Includes traditional and digital channels. Development of a marketing communications plan, situation analysis, setting communication goals, creating message strategy, implementing the strategy using promotional mix variables, planning traditional and social media, and determining the communication budget. Junior standing.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4354 - Marketing Channels and Logistics (3 credits)
Management of the firms distribution function. Study of the structure, functions, interactions, and activities of marketing channels. Analysis and development of integrated physical distribution and logistics systems for the firm. Junior standing required.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604) and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4404 - Field Practicum in Marketing (3 credits)
Application of marketing concepts and theories to a specific business concept. On-site performance of marketing activities and a written analysis of the firms marketing strategy and execution. Junior Standing
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4454 - Sales Force Management (3 credits)
Integration of behavioral research to provide an understanding of the role of the salesperson within the sales organization and in relation to the buyers. Personal selling examines the dyadic interaction between buyer and seller. Managing the sales force covers planning, organizing, directing, and controlling the activities of the sales personnel. Junior standing required.
Prerequisite(s): MKTG 4554 and (MKTG 3104 or MKTG 3104H) and MKTG 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4554 - Principles of Professional Selling (3 credits)
Learn about the management of relationships between buyers and sellers to effectively build partnerships, including the importance of understanding buyer behavior to facilitate the sales process. Explore the concepts of prospecting for customers, planning for the sales call, presentation skills, as well as the formal negotiation process and how these areas relate to adaptive selling. Address common sales management issues including how to manage cross-functional teams and their time and territories, as well as explore the ethical and legal issues that often arise throughout the sales process. Discuss the various career paths and opportunities within sales.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4604 - Retail Management (3 credits)
Analysis of managerial problems in retailing establishments, including traditional and online formats. Focus is on operational problems, retail and e-retail store organization, location analysis, buying, selling, sales promotion, and merchandise handling. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4644 - Marketing, Society and the Public Interest (3 credits)
The impact of marketing on society from a multi- disciplinary and multi-stakeholder perspective. Marketings role in solving societal problems is explored. Topics include at-risk market segments, controversial products and practices, and issues of social justice.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4704 - International Marketing (3 credits)
Assessing international markets, comparing marketing systems; management of international marketing operations; focusing on distribution, promotional, and pricing problems faced by firms engaging in world trade. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4734 - Real Estate Marketing (3 credits)
This course extends the fundamental concepts of marketing into the study and practice of real estate. The course is concerned with the topics of demographic analysis, market information systems, market research, and marketing strategy of residential and commercial real estate, with particular emphasis on the important area of real estate personal selling. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4754 - Strategic Marketing (3 credits)
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites–4304, 4354, 4554--may be taken concurrently with 4754.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4754H - Stategic Marketing (3 credits)
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites - 4304, 4354, 4554 - may be taken concurrently with 4754H
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4774 - Advanced Professional Selling (3 credits)
Advanced theory and practice of professional selling with primary focus on the professional sales process, analysis of associated strategic and ethical issues, and acquisition of critical skills required of successful salespeople. Builds on foundation created in Buyer/Seller Relationship (MKTG 4554) to expand knowledge and skills of students considering career in professional sales.
Prerequisite(s): MKTG 4554 and MKTG 4204 and (MKTG 3104 or MKTG 3104H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4964H - Field Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MKTG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4994H - Honors Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Materials Science and Engineering (MSE)

MSE 1004 - Materials In Todays World (1 credit)
An introductory course designed for the student with a basic high school science background who wishes to understand and learn about the exciting materials developments which are affecting us all in todays world. The course will introduce the structures and properties of metals, ceramics, polymers (plastics), composites, and materials for electronic and optical applications. Students will also gain an appreciation for the processing and design limitations of materials used in everyday applications.
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 1014 - The Science of Materials in Everyday Life (3 credits)
Introduction to the science of materials using everyday applications in modern society from medicine, transportation, sports, art, music, infrastructure, and electronics. Discussion of metals, ceramics, plastics, biomaterials, and hybrid materials based on the fundamental science dictating their structure properties, and processing. Considerations of tradeoffs between environmental sustainability, ethical and societal issues, and economics for materials choices.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2014 - Materials Engineering Transition (1 credit)
Supplemental coverage of introductory topics not included in courses delivered to non-MSE majors.
Prerequisite(s): MSE 2034 or MSE 3094 or AOE 3094
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2034 - Elements of Materials Engineering (3 credits)
This course is designed to introduce the non-MSE student to the structures and properties of metals, ceramics, polymers, and composites. In addition, students will gain an understanding of the processing and design limitations of these materials, as well as being introduced to new classes of materials being developed to meet the ever expanding range of material requirements. Non-MSE majors only.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2044 - Fundamentals of Materials Engineering (4 credits)
This course is designed to introduce the MSE major to the structures and properties of metals, ceramics, polymers, composites, and electronic materials. Students will also gain an understanding of the processing and design limitations of materials. Topics fundamental to the further study of materials, such as crystal structures, phase diagrams, and materials design and processing will be emphasized as foundations for future MSE courses.
Prerequisite(s): CHEM 1035
Corequisite(s): PHYS 2305
Instructional Contact Hours: (4 Lec, 4 Crd)

MSE 2054 - Fundamentals of Materials Science (3 credits)
Introduces MSE majors to fundamental underlying concepts governing phase equilibrium, microstructure, electronic properties of materials, and transport phenomena as a foundation to understanding materials behavior and processing.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2114 - Math Programming MSE I (1 credit)
Basic computational and graphical functions in mathematics oriented programming languages using data and engineering examples from the field of Materials Science. Students apply general methods to problems of their choice through mini- projects.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2884 - Materials Engineering Professional Development I (1 credit)
Topics on professional, communications, and leadership skills in entering the engineering workplace; building and presenting qualifications for professional development; expanding the professional network; and ethical, diversity, inclusion, and equity in the engineering workplace. Career gap analysis, team dynamics, resumes, job interviews, cover letters, scholarship essays, personal statements, professional development portfolios, case studies, poster presentations. Pre: Sophomore standing in the MSE major.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2984D - Special Study (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

MSE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 3044 - Transport Phenomena in MSE (3 credits)
Mass transport (continuum and atomistic diffusion), heat transport and fluid flow (momentum transport). Analytical and computer based methods for solving transport problems.
Prerequisite(s): MSE 2044 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3054 - Mechanical Behavior of Materials (3 credits)
Mechanical properties and behavior of engineering materials subjected to static, dynamic, creep, and fatigue loads under environments and stress states typical of service conditions; biaxial theories of failure; behavior of cracked bodies; microstructure-property relationships and design methodologies for homogeneous and composite materials.
Prerequisite(s): ESM 2204 and (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 3054

MSE 3064 - Mechanical Behavior of Materials Laboratory (1 credit)
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers.
Prerequisite(s): ESM 2204
Corequisite(s): MSE 3054
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ESM 3064

MSE 3104 - Mineralogy (3 credits)
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester.
Prerequisite(s): CHEM 1035 or CHEM 1055 or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOS 3504

MSE 3114 - Mathematics Programming in Materials Science II (1 credit)
Advanced computational and graphical methods in mathematics oriented programming languages. Students develop programs that solve and/or provide visualizations of solutions to materials science and engineering problems.
Prerequisite(s): MSE 2114
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 3134 - Crystallography and Crystal Structures (3 credits)
Provides a comprehensive foundation in crystallography including lattices, point groups, space groups, reciprocal lattices, properties of x-rays, and electron density maps, all leading to a formal description of structures and an interpretation of the published crystallographic data.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3204 - Fundamentals of Electronic Materials (3 credits)
Introduction to the electrical, magnetic, and optical properties of solid-state materials. Development of atomic scale models for physical phenomena that are observable at the macroscopic scale. Connection is made between basic materials properties and the operational characteristics of selected solid-state devices.
Prerequisite(s): MSE 2054 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3304 - Physical Metallurgy (3 credits)
Deformation of crystalline solids and its relationship to crystal structure and crystal defects: crystal structures of metals, dislocations and plastic deformation, vacancies, recovery, recrystallization, grain growth, deformation twinning and martensite.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3314 - Materials Laboratory I (1 credit)
Sample preparation for materials characterization techniques including various types of microscopy, spectroscopy, diffraction, and hardness testing. Instruction in the use of heat treating equipment and polishing and chemical etching procedures.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 3324 - Elementary Metal Casting Laboratory (1 credit)
Introduction to metal casting processes; gating, risering, molding and puring. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required.
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): MSE 3354
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 3334 - Test Methods for Foundry Laboratories (2 credits)
The properties of foundry sand, molten metal and castings are measured using standard laboratory test procedures. Safe foundry practices are emphasized. Oral and written reports are required.
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): MSE 3354
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MSE 3354 - Foundry Safety (1 credit)
Provides comprehensive training in foundry safety procedures and policies. (May register multiple times).
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): 3324 or 3334 or 4324.
Instructional Contact Hours: (2 Lec, 1 Crd)

MSE 3884 - Materials Engineering Professional Development II (1 credit)
Teamwork, ethical, professional, and communication practices in collaborative engineering environments; identification of areas of interest for potential senior design capstone projects; discipline-specific preliminary research in preparation for senior design projects: motivations and needs identification, broader impact (economic, social, environmental, and global), relevant theoretical concepts and methodologies, ethical engineering considerations, management logistic such identification of facilities and equipment, risk and safety analysis, critical paths and project timelines; basic project and time management; collaborative communications in written and oral form, personal professional development plans. Extends the basic treatment of these topics given in MSE 2884. Pre: Junior standing in the MSE major.
Prerequisite(s): MSE 2884
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 3954 - Study Abroad (1-6 credits)
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

MSE 4034 - Thermodynamics of Materials Systems (3 credits)
Topics in thermodynamics on the solution of materials selection and design related problems such as materials stability at high temperatures and in corrosive chemical environments. Thermodynamic principles important in controlling equilibrium in single component systems and multicomponent solid solutions and in establishing the thermodynamic driving force in kinetic processes which are important in materials processing unit operations. Estimation of thermodynamic properties and equilibrium calculations in multicomponent and multiphase systems.
Prerequisite(s): MSE 2044
Corequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4044 - Powder Processing (3 credits)
Processing methods associated with powder synthesis, characterization, colloidal processing, and forming of powder compacts. Theory of solid state and liquid phase sintering.
Prerequisite(s): MSE 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4055 - Materials Selection and Design I and II (3 credits)
4055: Selection of materials for engineering systems, based on constitutive analyses of functional requirements and material properties. 4056: The role and implications of processing on material selection.
Prerequisite(s): (MSE 3204 and MSE 3304) or (MSE 3204 and MSE 4414) or (MSE 3204 and MSE 4554) or (MSE 3304 and MSE 4414) or (MSE 3304 and MSE 4554) or (MSE 4414 and MSE 4554)
Corequisite(s): MSE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4056 - Materials Selection and Design I and II (3 credits)
4055: Selection of mateials for engineering systems, based on constitutive analyses of functional requirements and material properties. 4056: The role and implications of processing on material selection.
Prerequisite(s): MSE 4055
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4075 - Senior Design Laboratory (1 credit)
A capstone design course centered around an open-ended, faculty-advised senior project involving the design of a process, material, or a technique for solving a technological problem. Senior standing in MSE required.
Prerequisite(s): MSE 4644
Corequisite(s): MSE 4055, MSE 4085
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4076 - Senior Design Laboratory (2 credits)
A capstone design course centered around an open-ended, faculty-advised senior project involving the design of a process, material, or a technique for solving a technological problem. Senior standing in MSE required.
Prerequisite(s): MSE 4075
Corequisite(s): MSE 4086
Instructional Contact Hours: (6 Lab, 2 Crd)

MSE 4085 - Senior Capstone Recitation (2 credits)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 3884
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MSE 4085H - Senior Capstone Recitation (2 credits)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 3884
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Instructional Contact Hours: (2 Lec, 2 Crd)

MSE 4086 - Senior Capstone Recitation (1 credit)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 4085
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 4095H - Honors Senior Design-Laboratory (3 credits)
Two-semester MSE capstone design course centered around an open-ended, faculty-advised senior honors project involving the design of a process, material, or a technique for solving a technological problem. Outcomes and work effort are consistent with that expected of honors students. MSE 4095H: Literature search, planning and proof-of-concept studies of assigned project. Individual preparation and presentation of an original senior honors thesis related to a team project in which the students also participate. Presentation of detailed project plan to faculty. MSE 4096H: Execution of proposed project, analysis of results and preparation of journal-quality presentation of results. Oral presentation of results to MSE faculty and students. Enrollment in University Honors and senior standing in MSE required.
Prerequisite(s): MSE 4644
Corequisite(s): MSE 4055, MSE 4085
Instructional Contact Hours: (9 Lab, 3 Crd)

MSE 4096H - Honors Senior Design Laboratory (3 credits)
Two-semester MSE capstone design course centered around an open-ended, faculty-advised senior honors project involving the design of a process, material, or a technique for a solving a technological problem. Outcomes and work effort are consistent with that expected of honors students. MSE 4096H: Execution of proposed project, anaylsis of results and preparation of journal-quality presentation of results. Oral presentation of results to MSE faculty and students. Enrollment in University Honors and senior standing in MSE required.
Prerequisite(s): UH 4095H
Corequisite(s): MSE 4086
Instructional Contact Hours: (9 Lab, 3 Crd)

MSE 4164 - Principles of Materials Corrosion (3 credits)
Introduction to the scientific principles of materials corrosion and corrosion protection. Topics include: thermodynamics of materials corrosion, including potential- PH (Pourbaix) diagrams, kinetics of corrosion reactions and mixed potential theory, types of corrosion (uniform, galvanic, crevice, pitting, fatigue, stress corrosion cracking, intergranular, and hydrogen embrittlement), material/environmental factors that promote or prevent the various types of corrosion, and methods and techniques of corrosion testing.
Corequisite(s): MSE 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4174 - Corrosion and Degradation of Materials Laboratory (1 credit)
Introduction to experimental techniques and principles used to study the effects of environmental exposure on various contemporary advanced materials systems. Emphasis on creation and measurement of property variations in engineered materials caused by time and chemical or energetic stimuli, and effective communication of these results.
Prerequisite(s): MSE 4034 and MSE 3314 and MSE 4424
Corequisite(s): MSE 3044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4224 - Electronic, Magnetic, and Optical Properties of Materials Laboratory (1 credit)
Introduction to experimental techniques used to study the electronic, magnetic, and optical properties of contemporary advanced materials systems; property variations made possible by composition and processing of engineered materials; and interaction of fields with materials – including effective communication of these results.
Prerequisite(s): MSE 3204 and MSE 3314 and MSE 4424
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4234 - Semiconductor Processing (3 credits)
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4234

MSE 4304 - Metals and Alloys (3 credits)
This course covers the production, properties and uses of commercially important metals and alloys. The influence of structure, chemistry, and processing upon the properties of metals is emphasized. Alloy selection is discussed. Mechanical, electrical, thermal and chemical characteristics of ferrous and nonferrous alloys are studied.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4305 - Physical Metallurgy and Modeling of Metal Casting (3 credits)
4305: Casting processes; solidification and its influences on the structure and chemistry of castings; role of fluid flow and heat transfer in mold design; origin and control of casting defects. 4306: Design, layout, and modeling of metal components cast from aluminum, bronze, iron and steel; design of metal running systems; modeling of solidification process.
Prerequisite(s): MSE 3304
Corequisite(s): 3044 or ME 3304 for 4306.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4306 - Physical Metallurgy and Modeling of Metal Casting (3 credits)
4305: Casting processes; solidification and its influence on the structure and chemistry of castings; role of fluid flow and heat transfer in mold design; origin and control of casting defects. 4306: Design, layout, and modeling of metal components cast from aluminum, bronze, iron and steel; design of metal running systems; modeling of solidification processes.
Prerequisite(s): (MSE 2034 or MSE 2044) and MSE 3324
Corequisite(s): 3044 or ME 3304 for 4306.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4314 - Bladesmithing (3 credits)
Introduction to bladesmithing processes. Hands-on experience with heating metal, visual temperature measurement, manual hammer forging, forge welding, cooling metal, and heat treatment. Emphasis on safe forging and bladesmithing practices.
Corequisite(s): MSE 3304, MSE 3354
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MSE 4324 - Advanced Metal Casting Laboratory (2 credits)
Advanced metal casting processes; no-bake sand molds; investment casting; rapid prototyping; melting and casting of aluminum, bronze, iron and steel. Casting finishing including shot and sand blasting. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required.
Prerequisite(s): MSE 3324
Corequisite(s): MSE 3354
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MSE 4334 - Applied Materials Analysis (3 credits)
Fundamental materials theory applied to structure-property relationships in materials science and engineering through basic characterization techniques. Demonstrations, lab exercises, and practical application of modern characterization techniques such as Scanning and Transmission Electron Microscopy (SEM, TEM), Focused Ion Beam (FIB), and Atomic Force Microscopy (AFM).
Prerequisite(s): MSE 2044 and (MSE 3314 or MSE 4424)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MSE 4384 - Nuclear Materials (3 credits)
An introduction to materials for nuclear applications with emphasis on fission reactors. Fundamental radiation effects on materials; material properties relevant to structural, moderator, reflector, blanket, coolant, control shielding and safety systems; processes such as nuclear fuel cycles, fuel enrichment and reprocessing; and related structural systems.
Prerequisite(s): (MSE 3044 or ME 3304) and (MSE 3054 or ESM 3054 or ME 3614)
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4394 - Introduction to Molecular Dynamics Simulation (3 credits)
Background of molecular dynamics simulation method. Fundamental molecular dynamics principles, algorithms and components (atomic structure, periodic boundary conditions, interatomic potentials, equations of motion of atoms, statistical ensembles, integration of equations of motion). Implementation of algorithms into codes. Simulations of the time evolution of atoms, particles, or molecules under static or varying thermodynamic conditions and external loads. Connection between atom trajectories and evolution of the physical property of the simulation system with statistical mechanics principles. Hands-on case studies using molecular dynamics simulation package, LAMMPS. Prior knowledge of a programming language such as Fortran, C, C++, Matlab, Mathematica, Python, Java is highly recommended. Pre: Junior standing.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4414 - Physical Ceramics (3 credits)
Study of the relationships between the physical properties (thermal, optical, mechanical, electrical and magnetic) and the structure and composition of ceramics at the atomic and microscopic level as affected by processing and service environment. Emphasis will be placed on application and design using structural ceramics.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4424 - Materials Laboratory II (1 credit)
Processing and characterization of materials; exploration of the influence of processing parameters on physical and mechanical properties. Emphasis on material synthesis.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4434 - Ceramic and Glass Materials Processing Laboratory (1 credit)
Introduction to experimental techniques used to synthesize, process, and analyze resulting properties of ceramic and glass materials. Measurement of property variations made possible by changing composition and processing of engineered ceramic systems.
Prerequisite(s): MSE 4414 and MSE 3314 and MSE 4424
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4544 - Laboratory In Polymer Science (2 credits)
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems.
Prerequisite(s): CHEM 3616 and CHEM 4534
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: CHEM 4074

MSE 4554 - Polymer Engineering (3 credits)
This course is designed to introduce the student to polymers from the MSE perspective. The basics of polymer syntheses and polymerization will be outlined. The relationship between processing, structure, and properties will be presented with respect to the performance and design requirements of typical polymer applications.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4574 - Biomaterials (3 credits)
Materials for biomedical applications. Basic material types and properties, functional uses of materials in medical applications, and tissue response mechanisms. Integrated design issues of multicomponent material design in prosthetic devices for hard and soft tissues, orthopedics , cardiovascular, and drug delivery applications.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4574

MSE 4584 - Biomimetic Materials (3 credits)
Introduction to structure property relationships in biological materials such as wood, bone, shells, spider silk, connective tissue, blood vessels and jellyfish. Proteins and polysaccharides, biosynthesis and assembly, biomineralization, hierarchical organization. Introduction to tissue engineering and regenerative medicine. Life cycle, environmental aspects of biofabrication.
Prerequisite(s): (MSE 2034 or MSE 2044) and (CHEM 1036 or BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4604 - Composite Materials (3 credits)
The application of the fundamental concepts of mechanics, elasticity, and plasticity to multiphase and composite materials. Constitutive equations for the mechanical and physical properties of metal, ceramic, and polymeric matrix composites. The role of processing and microstructure on properties.
Prerequisite(s): (MSE 2034 or MSE 2044) and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4614 - Nanomaterials (3 credits)
Synthesis methods of 0D nanoparticles, 1D nanotubes/nanowires/nanorods, 2D nanoribbons and nanofilms, and special nano-features on supports. Bottom-up and top-down approaches. Methods of characterization for nanomaterials. Processing of nanospecies into higher order dimensions; conventional processing techniques; techniques developed solely for nanomaterials. Chemical, physical, mechanical, and electrical properties of nanomaterials and applications of nanomaterials.
Prerequisite(s): MSE 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4644 - Materials Optimization Through Designed Experiments (3 credits)
Methods of analysis of variation in materials systems, manufacturing or R&D through the use of statistical methods including experimental design techniques. Instructional examples related to Materials Science and Engineering.
Prerequisite(s): MSE 3314 or MSE 4424
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

MSE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 29844 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Mathematics (MATH)

MATH 1004 - Discovering Mathematics I (1 credit)
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics such as logic systems, recreational mathematics, LaTeX programming, history, ethics, open problems, and research in mathematics. Also includes advising topics such as planning a Virginia Tech course of study. P/F only. Math majors.
Instructional Contact Hours: (1 Lec, 1 Crd)

MATH 1014 - Precalculus with Transcendental Functions (3 credits)
Precalculus college algebra, basic functions (algebraic, exponential, logarithmic, and trigonometric), conic sections, graphing techniques, basic probability. Usage of mathematical models, analytical calculations, and graphical or numerical representations of data to analyze problems from multiple disciplines that address intercultural and global challenges in areas such as chemistry, environmental science, the life sciences, finance, and statistics. Use of spreadsheet software. Two units of high school algebra and one of plane geometry are required.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1025 - Elementary Calculus (3 credits)
Quantitative and computational thinking to address relevant global issues. Unified calculus course covering techniques and applications of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for the life sciences. 1025: Differential calculus, graphing, applications for the life sciences, use of spreadsheet software. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit of trigonometry and precalculus. 1026: Integral calculus, numerical techniques, elementary differential equations, applications for the life sciences, use of spreadsheet and scientific software. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1026 and 1226.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1026 - Elementary Calculus (3 credits)
Quantitative and computational thinking to address relevant global issues. Unified calculus course covering techniques and applications of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for the life sciences. 1025: Differential calculus, graphing, applications for the life sciences, use of spreadsheet software. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit of trigonometry and precalculus. 1026: Integral calculus, numerical techniques, elementary differential equations, applications for the life sciences, use of spreadsheet and scientific software. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1026 and 1226.
Prerequisite(s): MATH 1025 or MATH 1225
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1044 - Discovering Mathematics II (2 credits)
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics in pure and applied mathematics and a brief experience with mathematical research. Also includes advising topics such as planning a Virginia Tech course of study. Math majors.
Instructional Contact Hours: (2 Lec, 2 Crd)

MATH 1214 - Preparation for Calculus (3 credits)
Linear equations, polynomials, relations and functions, rational functions, quadratic equations, radicals and functions with rational exponents, exponentials, logarithms, trigonometric functions, trigonometric identities. Designed as preparation for MATH 1225: Calculus of a Single Variable.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1225 - Calculus of a Single Variable (4 credits)
1225-1226: CALCULUS OF A SINGLE VARIABLE Quantitative and computational thinking to address relevant intercultural and global issues. Unified calculus course covering techniques of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for science and engineering. 1225: limits, continuity, differentiation, transcendental functions, applications of differentiation, introduction to integration. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and precalculus, and placement by Math Dept. 1226: techniques and applications of integration, trapezoidal and Simpson's rules, improper integrals, sequences and series, power series, parametric curves and polar coordinates, software-based techniques. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1525 and 1225. A student can earn credit for at most one of 1026 and 1226. Pre: Grade of at least C- in 1225 for 1226.
Prerequisite(s): MATH 1214
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1226 - Calculus of a Single Variable (4 credits)
1225-1226: CALCULUS OF A SINGLE VARIABLE Quantitative and computational thinking to address relevant intercultural and global issues. Unified calculus course covering techniques of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for science and engineering. 1225: limits, continuity, differentiation, transcendental functions, applications of differentiation, introduction to integration. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and precalculus, and placement by Math Dept. 1226: techniques and applications of integration, trapezoidal and Simpson's rules, improper integrals, sequences and series, power series, parametric curves and polar coordinates, software-based techniques. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1525 and 1225. A student can earn credit for at most one of 1026 and 1226. Pre: Grade of at least C- in 1225 for 1226.
Prerequisite(s): MATH 1225
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1454 - Introduction to Programming for Mathematical Problem-Solving (3 credits)
Introduction to programming for mathematical problem solving. Programming software interfaces. Logic and conditional computations. Iterative computations and recursion. Data arrays. Compartmentalized computations using functions. Data visualization. Data input/output. Programming applications such as Monte Carlo simulation, random walks, computational geometry, and graph theory.
Corequisite(s): MATH 1225
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1524 - Business Calculus (4 credits)
Differential calculus techniques for functions of one and two variables. Emphasis on graphs, rates of change, and optimization of linear, quadratic, exponential, and logistic functions. Terminology and applications for business, including spreadsheet software. Mathematical models of real-world business problems, including discrete and continuous models, that address intercultural and global challenges in such areas as finance, marketing, and accounting. Assumes 2 units of high school algebra and 1 unit of geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1535 - Geometry and Mathematics of Design (3 credits)
A standard first-year mathematics sequence for architecture majors. Mathematical models of real-world problems, including discrete and continuous models, that address relevant global challenges in such areas as urban planning, building construction, and home design. 1535: Euclidean geometry, trigonometry, sequences and the golden ratio, graph theory, tilings, polygons and polyhedra, applications for 2- and 3-dimensional design and construction, use of geometric software. 1536: vectors in the plane and space, descriptive and projective geometry, differential and integral calculus, applications for 2- and 3-dimensional design and construction, including areas, volumes, centroids, and optimization. Assumes 2 unites of high school algebra and 1 unit of high school geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1536 - Geometry and Mathematics of Design (3 credits)
A standard first-year mathematics sequence for architecture majors. Mathematical models of real-world problems, including discrete and continuous models, that address relevant global challenges in such areas as urban planning, building construction, and home design. 1535: Euclidean geometry, trigonometry, sequences and the golden ratio, graph theory, tilings, polygons and polyhedra, applications for 2- and 3-dimensional design and construction, use of geometric software. 1536: vectors in the plane and space, descriptive and projective geometry, differential and integral calculus, applications for 2- and 3-dimensional design and construction, including areas, volumes, centroids, and optimization. Assumes 2 unites of high school algebra and 1 unit of high school geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1614 - Numbers and Operations for Teachers (3 credits)
Study of the nature and structure of numbers for prospective elementary and middle school teachers; number theory, number systems, operations and algebraic thinking, problem solving, and mathematical modeling. 1614 may not be taken by math majors for credit.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1624 - Geometry for Teachers (3 credits)
Study of key geometry concepts for prospective elementary and middle school teachers; multiple perspectives including transformational, coordinate, Euclidean and analytical geometry; geometric modeling; geometric and spatial reasoning. 1624 may not be taken by math majors for credit.
Prerequisite(s): MATH 1614
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2114 - Introduction to Linear Algebra (3 credits)
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases, orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114 and 2405H.
Prerequisite(s): MATH 1225 or MATH 1226 or
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2114H - Introduction to Linear Algebra (3 credits)
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases, orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114H and 2405H.
Prerequisite(s): MATH 1225 or MATH 1226 or
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2204 - Introduction to Multivariable Calculus (3 credits)
Calculus for functions for several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204 and 2406H. A student can earn credit for at most one of 2024 and 2204. A student can earn credit for at most one of 2204 and CMDA 2005.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2204H - Introduction to Multivariable Calculus (3 credits)
Calculus for functions of several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204H and 2406H. A student can earn credit for at most one of 2024 and 2204H. A student can earn credit for at most one of 2204H and CMDA 2005.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2214 - Introduction to Differential Equations (3 credits)
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214 and 2406H. A student can earn credit for at most one of 2214 and CMDA 2006.
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H or ISC 2105) and MATH 1226
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2214H - Introduction to Differential Equations (3 credits)
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214H and 2406H. A student can earn credit for at most one of 2214H and CMDA 2006
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H or ISC 2105) and MATH 1226
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2405H - Mathematics in a Computational Context (5 credits)
Unified course covering topics from linear algebra, differential equations, and calculus for functions of several variables. Comprises the standard second year mathematics courses for science and engineering. 2405H: Vector and matrix algebra, systems of linear equations, linear independence, bases, orthonormal bases, rank, linear transformations and diagonalization. Ordinary linear homogeneous differential equations, implementation with contemporary software. 2406H: Ordinary nonhomogeneous differential equations, calculus for functions of several variables, planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, with software-based techniques. A student can earn credit for at most one of 2114, 2114H, and 2405H. A student can earn credit for at most one of 2204, 2204H, and 2406H. A student can earn credit for at most one of 2214, 2214H, and 2406H.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (5 Lec, 5 Crd)

MATH 2406H - Mathematics in a Computational Context (5 credits)
Unified course covering topics from linear algebra, differential equations, and calculus for functions of several variables. Comprises the standard second year mathematics courses for science and engineering. 2405H: Vector and matrix algebra, systems of linear equations, linear independence, bases, orthonormal bases, rank, linear transformations and diagonalization. Ordinary linear homogeneous differential equations, implementation with contemporary software. 2406H: Ordinary nonhomogeneous differential equations, calculus for functions of several variables, planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, with software-based techniques. A student can earn credit for at most one of 2114, 2114H, and 2405H. A student can earn credit for at most one of 2204, 2204H, and 2406H. A student can earn credit for at most one of 2214, 2214H, and 2406H.
Prerequisite(s): MATH 2405H
Instructional Contact Hours: (5 Lec, 5 Crd)

MATH 2534 - Introduction to Discrete Mathematics (3 credits)
Emphasis on topics relevant to computer science. Topics include logic, propositional calculus, set theory, relations, functions, mathematical induction, elementary number theory and Boolean algebra. Does not carry credit for mathematics majors, but may be used as though it were a 3000-level elective course for the mathematics minor. Two units of high school algebra, one unit of geometry, one-half unit each of trigonometry and precalculus mathematics required. 2534 may not be taken by math majors for credit without special permission. A student can earn credit for at most one of 2534 and 3034.
Prerequisite(s): CS 1114 or ECE 1574 or ECE 1004 or CS 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2644 - Mathematics Tutoring (1 credit)
Introduction to professional, culturally respectful mathematics tutoring. Development of listening and questioning skills, assessment of students' mathematical difficulties. Exploration of teaching and learning processes, effectively utilizing technology, and adjusting instruction to diversity in students' mathematical reasoning. Concurrent mathematics tutoring experience required. May be repeated twice with different leadership expectations for a maximum of 3 credits.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

MATH 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MATH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 3034 - Introduction to Proofs (3 credits)
Practice in writing mathematical proofs. Exercises from set theory, number theory, and functions. Propositional logic, set operations, equivalence relations, methods of proof, mathematical induction, the division algorithm and images and pre-images of sets. A student can earn credit for at most one of 2534 and 3034.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3124 - Modern Algebra (3 credits)
Introduction to abstract algebraic structures (groups, rings, and fields) and structure-preserving maps (homomorphisms) for these structures. Proof-intensive course illustrating the rigorous development of a mathematical theory from initial axioms.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3134 - Applied Combinatorics and Graph Theory (3 credits)
Emphasis on concepts related to computational theory and formal languages. Includes topics in graph theory such as paths, circuits, and trees. Topics from combinatorics such as permutations, generating functions, and recurrence relations.
Prerequisite(s): MATH 1226 and (MATH 2534 or MATH 3034)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3144 - Linear Algebra I (3 credits)
Introductory course in linear algebra. Abstract vector spaces, linear transformations, algorithms for solving systems of linear equations, matrix analysis. This course involves mathematical proofs.
Prerequisite(s): (MATH 3034 or MATH 2534) and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3214 - Calculus of Several Variables (3 credits)
Fundamental calculus of functions of two or more variables. Implicit function theorem, Taylor expansion, line integrals, Greens theorem, surface integrals.
Prerequisite(s): MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3224 - Advanced Calculus (3 credits)
Theory of limits, continuity, differentiation, integration, series. 3224 duplicates 4525.
Prerequisite(s): (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3414 - Numerical Methods (3 credits)
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and 4404.
Prerequisite(s): (CS 1044 or CS 1705 or CS 1114 or CS 1124) and MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3414

MATH 3574 - Applied Complex Variables (1 credit)
Arithmetic of complex numbers. Geometry of the complex plane. Geometry of exponentiation and roots. Complex exponential, trigonometric and hyperbolic functions. Continuity and differentiability. Analytic and harmonic functions.
Prerequisite(s): MATH 2204 or MATH 2204H
Instructional Contact Hours: (1 Lec, 1 Crd)

MATH 4044 - History of Mathematics (3 credits)
Historical development of mathematics from antiquity to modern times. Senior standing in mathematics or mathematics education required.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4124 - Introduction to Abstract Algebra (3 credits)
An introduction to the theory of groups and rings. Topics include normal subgroups, permutation groups, Sylows Theorem, Abelian groups, Integral Domains, Ideals, and Polynomial Rings.
Prerequisite(s): MATH 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4134 - Number Theory (3 credits)
Introduction to elementary number theory. Topics covered may include divisibility, greatest common divisors, unique prime factorization, congruences, Fermat's Little Theorem, Chinese Remainder Theorem, multiplicative number-theoretic functions, Diophantine equations, primitive roots, and the Quadratic Reciprocity Law.
Prerequisite(s): MATH 3034 or MATH 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4144 - Linear Algebra II (3 credits)
Second course in linear algebra. Similarity invariants, Jordan canonical form, inner product spaces, self-adjoint operators, selected applications.
Prerequisite(s): MATH 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4175 - Cryptography (3 credits)
4175: Introduction to classical and modern symmetric-key cryptography; alphabetic ciphers, block ciphers and stream ciphers; background in modular arithmetic and probability; perfect secrecy; linear and differential cryptanalysis; Advanced Encryption Standard; hashing. 4176: Introduction to modern public-key cryptography and cryptanalysis; RSA algorithm, ElGamal algorithm, Diffie-Hellman algorithm; digital signatures; background in group theory and number theory; algorithms for primality testing, factoring, and discrete logarithms; elliptic curves.
Prerequisite(s): MATH 3034 or MATH 3124 or MATH 3134 or MATH 3144 or MATH 3224 or MATH 4134 or CMDA 3605
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4176 - Cryptography (3 credits)
4175: Introduction to classical and modern symmetric-key cryptography; alphabetic ciphers, block ciphers and stream ciphers; background in modular arithmetic and probability; perfect secrecy; linear and differential cryptanalysis; Advanced Encryption Standard; hashing. 4176: Introduction to modern public-key cryptography and cryptanalysis; RSA algorithm, ElGamal algorithm, Diffie-Hellman algorithm; digital signatures; background in group theory and number theory; algorithms for primality testing, factoring, and discrete logarithms; elliptic curves.
Prerequisite(s): MATH 4175 or CMDA 3606 or MATH 3034 or MATH 3134 or MATH 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4225 - Elementary Real Analysis (3 credits)
Real number system, point set theory, limits, continuity, differentiation, integration, infinite series, sequences and series of functions.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4226 - Elementary Real Analysis (3 credits)
Real number system, point set theory, limits, continuity, differentiation, integration, infinite series, sequences and series of functions.
Prerequisite(s): MATH 4225
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4234 - Elementary Complex Analysis (3 credits)
Analytic functions, complex integration, series representation of analytic functions, residues, conformal mapping, applications
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4245 - Intermediate Differential Equations (3 credits)
Solution techniques, linear systems, the matrix exponential, existence theorems, stability, non-linear systems, eigenvalue problems.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4254 - Chaos and Dynamical Systems (3 credits)
Survey of basic concepts in chaotic dynamical systems. Includes material on bifurcation theory, conjugacy, stability, and symbolic dynamics.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4324 - Elementary Topology (3 credits)
Basic concepts of topological spaces, continuous functions, connected spaces, compact spaces, and metric spaces.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4334 - College Geometry (3 credits)
Transformational approach to Euclidean geometry including an in-depth study of isometries and their application to symmetry, geometric constructions, congruence, coordinate geometry, and non-Euclidean geometries.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4404 - Applied Numerical Methods (3 credits)
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and 4404.
Prerequisite(s): MATH 4564 and (ESM 2074 or AOE 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4404

MATH 4414 - Issues in Scientific Computing (3 credits)
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006) and MATH 3214 and (CS 1114 or MATH 1454)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: CS 4414

MATH 4425 - Fourier Series and Partial Differential Equations (3 credits)
Separation of variables for heat, wave, and potential equations. Fourier expressions. Application to boundary value problems. Bessel functions. Integral transforms and problems on unbounded domains.
Prerequisite(s): MATH 2406H or CMDA 2006 or MATH 2214 or MATH 2214H and MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4426 - Fourier Series and Partial Differential Equations (3 credits)
Separation of variables for heat, wave, and potential equations. Fourier expressions. Application to boundary value problems. Bessel functions. Integral transforms and problems on unbounded domains.
Prerequisite(s): MATH 4425
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4445 - Introduction to Numerical Analysis (3 credits)
4445: Vector spaces and review of linear algebra, direct and iterative solutions of linear systems of equations, numerical solutions to the algebraic eigenvalue problem, solutions of general non-linear equations and systems of equations. 4446: Interpolation and approximation, numerical integration and differentiation, numerical solutions of ordinary differential equations. Computer programming skills required.
Prerequisite(s): MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4446 - Introduction to Numerical Analysis (3 credits)
4445: Vector spaces and review of linear algebra, direct and iterative solutions of linear systems of equations, numerical solutions to the algebraic eigenvalue problem, solutions of general non-linear equations and systems of equations. 4446: Interpolation and approximation, numerical integration and differentiation, numerical solutions of ordinary differential equations. Computer programming skills required.
Prerequisite(s): MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4454 - Applied Mathematical Modeling (3 credits)
Analysis of classical and modern applications of mathematics in the physical, biological and social sciences. Emphasis on problem formulating, modeling, solving, simulating, and analyzing results. Programming language required.
Prerequisite(s): MATH 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4564 - Operational Methods for Engineers (3 credits)
Laplace transformations, Fourier series, partial differential equations and separation of variables, boundary value problems, and Sturm-Liouville theory.
Prerequisite(s): (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4574 - Vector and Complex Analysis for Engineers (3 credits)
Vector Analysis: Greens theorem, potential theory, divergence, and Stokes theorem. Complex Analysis: Analyticity, complex integration, Taylor series, residues, conformal mapping, applications. 4574 may not be taken by math majors for credit.
Prerequisite(s): MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4625 - Mathematics for Secondary Teachers (3 credits)
Course activities will emphasize the curricular themes of problem solving, reasoning and proof, communication, connections, and representation. 4625: Topics in discrete mathematics and algebra from a secondary teaching perspective. 4626: Topics in trigonometry, geometry, measurement, statistics, and probability from a secondary teaching perspective.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4626 - Mathematics for Secondary Teachers (3 credits)
Course activities will emphasize the curricular themes of problem solving, reasoning and proof, communication, connections, and representation. 4625: Topics in discrete methematics and algebra from a secondary teaching perspective. 4626: Topics in trigonometry, geometry, measurement, statistics, and probability from a secondary teaching perspective.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4644 - Secondary School Mathematics With Technology (3 credits)
Use and impact of technology in secondary mathematics curriculum. Various technologies including graphing calculators, calculator based laboratory and probes (CBLs), computer algebra systems, spreadsheets, dynamic geometry software and the Internet will be used to explore secondary mathematical concepts from an advanced viewpoint.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4664 - Senior Math Education Seminar (2 credits)
A review of basic principles and problem-solving techniques in the eleven topics covered by the Praxis II (Mathematics Content Knowledge) examination. Passing the Praxis II examination prior to student teaching is a state requirement for all students seeking secondary licensure. Passing Praxis I required.
Prerequisite(s): MATH 3124
Instructional Contact Hours: (2 Lec, 2 Crd)

MATH 4754 - Internship (1-19 credits)
May be repeated for a maximum of 12 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

MATH 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MATH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Mechanical Engineering (ME)

ME 2004 - Engineering Analysis Using Numerical Methods (3 credits)
Numerical methods applied to engineering analysis with a design/lab studio. Numerical techniques including root finding, linear algebra, integration, ordinary differential equations, curve fitting, discrete Fourier transforms, optimization. Structured programming and iterative problem-solving using a high-level environment such as Matlab. Design/Lab Studio.
Prerequisite(s): (ENGE 1215 or ENGE 1414) and MATH 1226 and (MATH 2114 or MATH 2114H or MATH 2405H or MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ME 2024 - Introduction to Engineering Design and Economics (3 credits)
Design process, mini-design projects, collaborative design, product dissection, economics of decision making, reverse engineering, intellectual property, oral, written, and graphic communications, engineering ethics.
Prerequisite(s): ENGE 1216 or ENGE 1114 or ENGE 1434 or ENGE 1414
Corequisite(s): ESM 2104, MATH 2114, PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 2124 - Introduction to Thermal and Fluid Engineering (2 credits)
Basics of thermodynamics, fluid mechanics, and heat transfer. Fluid and thermal properties of materials. Ideal gas equation of state. First law of thermodynamics in closed systems. Transient heat transfer. First law of thermodynamics in open systems. Fluid mechanics balances, open systems. Emphasis on applications in all topic areas.
Prerequisite(s): (ESM 2104 or PHYS 2306) and (MATH 2114 or MATH 2114H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (2 Lec, 2 Crd)

ME 2134 - Thermodynamics (4 credits)
Classical (equilibrium) thermodynamics and its applications. Includes thermodynamic properties of pure substances: property diagrams, property tables, property software, equations of state; the first law of thermodynamics; the second law of thermodynamics; gas mixtures; combustion: atomic and energy balances; and power and refrigeration cycles.
Prerequisite(s): PHYS 2305 and (MATH 2204 or MATH 2204H or MATH 2406H) and CHEM 1035
Corequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H).
Instructional Contact Hours: (4 Lec, 4 Crd)

ME 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 3024 - Engineering Design and Economics (3 credits)
Engineering design process; project management; product planning; customer needs, specifications, and Quality Function Deployment (QFD); benchmarking and intellectual property; concept generation, screening, scoring, and selection; design for assembly, product architecture, economic, and ethical considerations; concept testing. Written and oral communications of engineering design; computer aided design. Team-based term project with prototype fabrication of mechanical assembly manipulated by a microcontroller. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ESM 2104 and ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3034 - Mechanical Engineering Discourse (1 credit)
Principles and application of effective technical and professional communication in mechanical engineering; organizing, structuring, and developing effective written documents and oral presentations for a range of audiences, including technical reports, memorandums, laboratory reports, live and recorded presentations, and posters for public exhibition; use of effective language and style; development of effective visual aids; presentation delivery skills; acquiring new knowledge using appropriate learning strategies by finding, comprehending and evaluating information from a variety of sources; ethical and professional responsibilities in both identifying appropriate information and communicating technical results. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

ME 3124 - Thermodynamics (3 credits)
Classical thermodynamics and its applications. Thermodynamic properties of pure substances: property tables, property software, equations of state. First law of thermodynamics. Second law of thermodynamics. Gas mixtures. Combustion: atom and energy balances. Power and refrigeration cycles.
Prerequisite(s): (ME 2124 and MATH 2214 and MATH 2204) or (ME 2124 and MATH 2214 and MATH 2204H) or (ME 2124 and MATH 2214 and MATH 2224) or (ME 2124 and MATH 2214 and MATH 2224H) or (ME 2124 and MATH 2214H and MATH 2204) or (ME 2124 and MATH 2214H and MATH 2204H) or (ME 2124 and MATH 2214H and MATH 2224) or (ME 2124 and MATH 2214H and MATH 2224H) or (ME 2124 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3134 - Fundamentals of Thermodynamics (3 credits)
Fundamental concepts, first and second laws, gas and vapor processes with emphasis on chemical reactions, statistical interpretation of entropy, limited use of thermodynamic property tables. This course is for non-ME students.
Prerequisite(s): MATH 2214 or MATH 2214H
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3194 - Technology, Innovation and Humanistic Engineering for a Sustainable Future (3 credits)
Foundational understanding of converging, emerging and disruptive technologies. Pedagogical aspects of innovation, team dynamics and effective communication. Leadership Cube—Six principles of effective leadership. Humanistic engineering. Sustainable energy and sustainable water platforms. Smart device designs for disease diagnostics and mitigation. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3304 - Heat and Mass Transfer (3 credits)
Comprehensive basic course in heat and mass transfer for mechanical engineering students. Principles of conduction, convection, and radiation with applications to heat exchangers and other engineering systems.
Prerequisite(s): ME 2134 and ME 3414 and (MATH 2214 or MATH 2214H or MATH 2306H) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3404 - Fluid Mechanics (3 credits)
Comprehensive first course in basic and applied fluid mechanics. Fluid properties, statics, kinematics, and dynamics. Eulers and Bernoullis equations. Hydrodynamics. Dimensional analysis and similitude. Real fluids, laminar and turbulent flows. Boundary layer model and approximate analysis. Compressible flow and propulsion devices. Flow measurement. Introduction to turbomachinery with applications.
Prerequisite(s): (ME 2124 and MATH 2214 and MATH 2204) or (ME 2124 and MATH 2214 and MATH 2204H) or (ME 2124 and MATH 2214 and MATH 2224) or (ME 2124 and MATH 2214 and MATH 2224H) or (ME 2124 and MATH 2214H and MATH 2204) or (ME 2124 and MATH 2214H and MATH 2204H) or (ME 2124 and MATH 2214H and MATH 2224) or (ME 2124 and MATH 2214H and MATH 2224H) or (ME 2124 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ME 3414 - Fluid Dynamics (4 credits)
Comprehensive first course in fluid dynamics. Fluid properties. Hydrostatics. Mass, momentum,and energy conservation in control volumes. Elementary dynamics and Bernoullis equation.Dimensional analysis and similitude. Laminar and turbulent flows. Introduction to Eulers and Navier-Stokes equations. Pipe flows. External flows and boundary layers. Introduction to compressible flows. Includes laboratory experiments.
Prerequisite(s): ME 2004 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2204 or MATH 2204H or MATH 2406H) and (MATH 2214 or MATH 2214H or MATH 2406H)
Corequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3504 - Dynamic Systems - Vibrations (3 credits)
Principles of dynamic system modeling with emphasis on second order mechanical systems. Harmonic and nonharmonic vibrations of single and multi-degree of freedom systems. Applications of computer simulation and analysis techniques in vibrations.
Prerequisite(s): (ME 3514 and MATH 2214) or (ME 3514 and MATH 2214H) or (ME 3514 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3514 - System Dynamics (3 credits)
Mathematical descriptions of physical systems behavior including mechanical, electrical, thermal, and fluid systems and their combinations; system descriptions using state variable and transfer functions; analysis of system responses: convolution integral, frequency response, numerical simulations, and Laplace transform methods; systems concepts: input-output, causality, and analogies; general process descriptions including first-order, second-order, and time delayed.
Prerequisite(s): (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3524 - Mechanical Vibrations (4 credits)
Development and application of mathematical methods, physical understanding, and computational tools for modeling, analysis, and design of vibrating systems. Free and forced vibration of single and multiple degree-of-freedom systems, particularly systems experiencing sinusoidal excitation. Distributed parameter systems. Practical engineering applications.
Prerequisite(s): ESM 2304 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2214 or MATH 2214H or MATH 2406H) and ME 2004
Instructional Contact Hours: (4 Lec, 4 Crd)

ME 3534 - Controls Engineering I (4 credits)
Fundamentals of feedback control theory, time-domain and frequency-domain analysis, automatic control system design synthesis to meet performance and stability requirements, numerical simulation and discrete real-time implementation on microcontrollers.
Prerequisite(s): ME 2004 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2214 or MATH 2214H or MATH 2406H) and (MATH 2204 or MATH 2204H or MATH 2406H) and ESM 2104 and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3604 - Kinematics and Dynamics of Machinery (3 credits)
Kinematic analysis and design of cams, gears, and linkages, velocity, acceleration and force analysis, kinematic synthesis, balancing, kinematic and force analysis by complex numbers, computer-aided analysis, and synthesis of linkages.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3614 - Mechanical Design I (3 credits)
Design of mechanical components subject to static and fatigue loads. Design using screws, fasteners, springs and bearings. Computer-aided design using transfer matrix and finite element methods.
Prerequisite(s): ESM 2204 and (MATH 2214 or MATH 2214H) and (MATH 2114 or MATH 2114H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3624 - Mechanical Design (4 credits)
Comprehensive first course in mechanical design. Stress and Strain. Fundamentals of designing mechanical components subjected to static and cyclical loads. Design elements for screws, fasteners, springs, and welds. Hands-on laboratory learning of concepts discussed in class. Course credit will not be awarded for both ME 3614 and ME 3624.
Prerequisite(s): ME 2004 and ESM 2204 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4005 - Mechanical Engineering Lab (3 credits)
Principles of measurement, measurement standards and accuracy, detectors and transducers, digital data acquisition principles, signal conditioning systems and readout devices statistical concepts in measurement, experimental investigation of engineering systems, technical report writing.
Prerequisite(s): (STAT 3704 or STAT 4604 or STAT 4705 or STAT 4714) and ME 3524 and ECE 2054
Corequisite(s): ME 3534
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4006 - Mechanical Engineering Lab (3 credits)
Principles of measurement, measurement standards and accuracy, detectors and transducers, digital data acquisition principles, signal conditioning systems and readout devices statistical concepts in measurement, experimental investigation of engineering systems, technical report writing.
Prerequisite(s): ME 4005 and ECE 3254
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4015 - Engineering Design and Project (3 credits)
Team oriented, open-ended, multi-disciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product realization and testing. Emphasis on documenting and reporting technical work. Making informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. 4015: Problem identification, including consideration of public health and welfare, as well as global, cultural, social, environmental, and economic factors and constraints; idea generation and concept selection; application of design, test, and analysis tools developed in previous courses; ethical and professional responsibilities; verification and validation; communication and working in teams. 4016: Project management; working on teams, analysis and optimization, fabrication and testing, and communicating technical ideas. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ME 3024 and ME 3034 and ME 3524 and ME 3534 and ME 3624 and ME 4005 and (ME 3304 or MSE 2034) and ME 3414
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4016 - Engineering Design and Project (3 credits)
Team oriented, open-ended, multi-disciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product realization and testing. Emphasis on documenting and reporting technical work. Making informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. 4015: Problem identification, including consideration of public health and welfare, as well as global, cultural, social, environmental, and economic factors and constraints; idea generation and concept selection; application of design, test, and analysis tools developed in previous courses; ethical and professional responsibilities; verification and validation; communication and working in teams. 4016: Project management; working on teams, analysis and optimization, fabrication and testing, and communicating technical ideas. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ME 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4034 - Bio-Inspired Technology (3 credits)
Introduction to engineering solutions inspired by biological systems. Overview over the approach of bio-inspired technology and the state of the art. Exploration of the relationship between engineered and natural biological systems. Explanation of concepts of biological systems, such as evolutionary optimization, sensing, actuation, control, system integration, assembly and materials in engineering terms. Practice of interdisciplinary analysis skills in technical report writing projects where man-made and biological systems are evaluated for parallels to engineering and their technological potential.
Prerequisite(s): (PHYS 2205 and PHYS 2206) or (PHYS 2305 and PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4124 - Computer Aided Design of Fluid-Thermal Systems (3 credits)
Review of physical laws and engineering concepts introduced in thermodynamics, fluid mechanics, and heat transfer with applications. Emphasis on analysis, modeling, and design of engineering systems, components, and physical phenomena with state-of-the-art computer software such as Ansys CFX, Star CCM, Aspen Plus, and ProSimPlus.
Prerequisite(s): (ME 3124 or ME 2134) and (ME 3404 or ME 3414) and ME 3304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ME 4154 - Industrial Energy Systems (3 credits)
Survey of energy-intensive technologies used in typical industrial plants, with emphasis on cost-effective energy conservation. Burners, boilers, pumps, air compressors, electric motors, lights, refrigeration plants, HVAC systems, cogeneration systems, waste heat recovery equipment. Energy-efficient design and operation. Determination of energy efficiency based on field measurements. Economic analysis of energy conservation measures. Mitigation of environmental impacts.
Prerequisite(s): ME 2134 or CHE 2164 or BSE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4164 - Energy Systems for Buildings (3 credits)
Application of the fundamental principles of thermodynamics, heat transfer, and fluid flow to analyze energy use for building environmental control. Exploration of approaches for configuring basic thermal-fluid engineering components (e.g. pumps, piping, fans, heat exchangers, refrigeration cycles, etc.) to yield systems that provide heating, cooling, and ventilation. Introduction to techniques and software tools for estimating energy use by these systems and the associated economic and environment impact. Examination of alternate technologies for meeting building energy needs including small scale combined heat and power systems and renewable energy systems.
Prerequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4174 - Spacecraft Propulsion (3 credits)
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues.
Prerequisite(s): AOE 3164 or AOE 4234 or ME 4234
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4174

ME 4184 - Drone Technology and Flight Operations (3 credits)
Basic aviation science, skills training in uncrewed flight operations, and knowledge of the regulatory environment that governs drone flight. Aerodynamics, propulsion, aircraft performance, sensing and control, meteorology, the Federal Aviation Regulations, safety and risk management. Flight management tools for conducting preflight inspections and approving flight missions. Pre: Students in Mechanical Engineering will be given preference, other programs and students eligible with permission.
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ME 4194 - Sustainable Energy Solutions for a Global Society (3 credits)
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764.
Prerequisite(s): (CHEM 1035 or CHEM 1055) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4194

ME 4204 - Internal Combustion Engines (3 credits)
Analysis and design of gasoline and diesel engines. Fundamental processes and their application in current technology. Thermodynamics: air standard and air-fuel cycles. Combustion: stoichiometry, fuels, chemical equilibrium, chemical kinetics, flame propagation, knock, pollutant formation and control. Flow processes: volumetric efficiency, intake and exhaust tuning, two-stroke scavenging, carburetion, fuel injection, super- and turbo-charging.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4224 - Gas Turbines for Power and Propulsion (3 credits)
Introduction to various applications of gas turbines for land, sea and air. Aero-thermo-mechanical aspects of component performance and reliability. Operational characteristics, limitations and component matching. Industrial standards, development and certification requirements. Design of gas turbine engines and comparison of the predicted performance (specific fuel consumption) against the in-service operation.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4234 - Aerospace Propulsion Systems (3 credits)
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements. Must have a C- or better in pre-requisites ME 3404 and ME 3124 or AOE 3114 and AOE 3134.
Prerequisite(s): AOE 3114 and (AOE 3164 or AOE 3264) or ME 3414 and ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4234

ME 4324 - Energy Systems: Theory and Applications (3 credits)
Theory and applications of thermodynamic and fluid mechanics principles as applied to energy systems. Fundamental concepts on exergy, mixtures, psychrometry and thermochemistry. Analyses and applications include vapor and gas power systems, refrigeration, air conditioning, combustion processes and one-dimensional compressible flow.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4344 - Biological Transport Phenomena (3 credits)
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation.
Prerequisite(s): (CHE 3114 and CHE 3044 and CHE 3144) or (ME 3304 and ME 3404)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4304

ME 4454 - Engineering Leadership in Practice: Managing the Technical Design Process (3 credits)
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor.
Prerequisite(s): ME 4015
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: EDCI 4454

ME 4464 - Introduction to Compressible Flows (3 credits)
Derivation of mass, momentum, and energy conservation equations for one dimensional (1-D), steady, inviscid, compressible gas flows of calorically perfect gases. Departure from incompressible flow theory. Importance of Mach number. Isentropic flows. Steady and unsteady 1-D normal shock flows. Oblique shock flows (with surface reflections) and/or Prandtl-Meyer expansion waves. Converging and converging-diverging quasi-1-D nozzle flows. Inviscid flows in straight ducts with heat addition; adiabatic flows in straight ducts with friction. Introduction to Newtonian hypersonic flow theory, high temperature effects, and rarefied gas principles.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4504 - Dynamic Systems - Controls Engineering I (3 credits)
Fundamentals of feedback control theory, classical analysis and design techniques for automatic controls, introduction to modern control theory.
Prerequisite(s): (ME 3514 and MATH 2214) or (ME 3514 and MATH 2214H) or (ME 3514 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4524 - Introduction to Robotics and Automation (3 credits)
Automation, robot technology, kinematics, dynamics, trajectory planning, and control of two-dimensional and spatial robots; robot programming; design and simulation of robotic devices.
Prerequisite(s): ME 2004 and ME 3524 and ME 3534
Corequisite(s): ME 4584
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4534 - Land Vehicle Dynamics (3 credits)
Analytical methods for land vehicle dynamics. Mechanics of pneumatic tires on pavement and steel wheels on rails. Vehicle stability, handling, response to random guideway and roadway irregularities, ride quality computation methods and standards, suspension design.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4544 - Automotive Engineering (3 credits)
Vehicle performance, drive train, suspension, steering, and brake systems. Steady state and transient conditions. Senior standing in Mechanical Engineering required.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4554 - Advanced Technology for Motor Vehicles (3 credits)
Energy use and environmental issues for motor vehicles: Emissions standards, fleet requirements, dynamometer testing, fuel economy, and vehicle performance. Alternative fuel vehicles: Characteristics and infrastructure of fuels, batteries, electric vehicles, and hybrid electric vehicles. Vehicle design: Modeling and simulation of vehicle energy use and performance, component sizing. Fuel cells for transportation. Heavy-duty vehicles and busses. Low mass vehicles and future vehicle technology.
Prerequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4564 - Vehicle Control (3 credits)
Overview of vehicle control systems and control algorithms for anti-lock braking, stability, road holding, lane departure, traction control, and tire pressure monitoring. Advanced driver assist systems and intelligent tire technology. Hands-on experience with hardware-in-the- loop systems. Mathematical modeling and simulation of vehicle control.
Prerequisite(s): ME 3524 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4584 - Robotics Laboratory (1 credit)
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and path planning.
Corequisite(s): ME 4524 or ECE 4704
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ECE 4584

ME 4614 - Mechanical Design II (3 credits)
Design of mechanical elements such as welded joints hydrodynamic bearings, spur gears, shafts, brakes. Alternative fatigue design methods, cumulative fatigue, mechanical design computer software.
Prerequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4624 - Finite Element Practice in Mechanical Design (3 credits)
Application of the finite element method to stress analysis problems in mechanical design. Modeling techniques, proper use of existing computer programs, interpreting of results, application to design modification.
Prerequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4634 - Introduction to Computer-aided Design and Manufacturing (3 credits)
Participants will study the computer-aided design and manufacturing of mechanical systems. A mechanical system will be designed including preliminary design, analysis, detail design, numerical control programming, and documentation. Applications programs will be written and interfaced to the CAD/CAM database. All assignments will be carried out on a CAD/CAM system.
Prerequisite(s): ME 3024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4644 - Introduction to Rapid Prototyping (3 credits)
Participants will study topics fundamental to rapid prototyping and automated fabrication, including the generation of suitable CAD models, current rapid prototyping fabrication technologies, their underlying material science, the use of secondary processing, and the impact of these technologies on society. The rapid prototyping process will be illustrated by the actual design and fabrication of a part. Programming skills required.
Prerequisite(s): ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4654 - Optimization Techniques in Engineering (3 credits)
Fundamental mathematical concepts for optimization and optimality conditions. Classification of optimization techniques/problems in engineering. Concepts of forward and inverse design. Linear programming. Step-size calculation methods. Search direction calculation methods. 1st and 2nd order gradient-based algorithms. Evolutionary strategies for optimization. Pattern search/genetic algorithm. Sensitivity analysis. Reliability-based and robustness-based optimization.
Prerequisite(s): ME 2004 or (AOE 2074 and CS 1044 and CS 1054 and CS 1064 and CS 1114 and CS 1124 and ECE 1574)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4664 - Introduction to Global Collegiate Engineering Design (3 credits)
Participants will study topics fundamental to global collaborative engineering design, product data management, and collaborative product data management. These topics will be applied during a team project with team members located overseas, utilizing state-of-the-art collaborative engineering and product data management software and hardware technologies. Partially duplicates 5664. Credit may only be received for one course.
Prerequisite(s): ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4674 - Materials Selection in Mechanical Design (3 credits)
Systematic approach to materials selection accounting for market need, functional requirements, shape, safety, cost and environmental issues. Overview of design process, material property charts, material indices, selection of materials with multiple constraints and/or conflicting objectives, shape factors, design considerations in hybrid materials, environmental issues as well as several case studies.
Prerequisite(s): ESM 2204 and MSE 2034
Corequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4684 - Industrial Internet of Things (3 credits)
Theory and applications of Industrial Internet of Things (IIoT). Industrial data flow, devices and network in manufacturing. Basics for IIoT architecture and implementation of IIoT solutions with cloud computing platforms and OEM IIoT platforms. Device connection, data transfer and application of diagnostics, maintenance, and predictive data analytics on IIoT platforms.
Prerequisite(s): ME 3534 or (CS 1044 or CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4724 - Engineering Acoustics (3 credits)
Basic acoustical theory and practice, acoustic terminology, measurement, transmission, and perception of sound, muffler design, noise control techniques.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4734 - Robotics and Mechatronics Seminar (1 credit)
Topics in robotics and mechatronics. Invited lectures from industry, government organizations and universities. Recent research results, developments and challenges, providing a global and social context for the topics.
Prerequisite(s): ME 3534 and ECE 3254
Instructional Contact Hours: (1 Lec, 1 Crd)

ME 4735 - Mechatronics (3 credits)
Electromechanical system modeling, control and applications. Design and building of electronic interfaces and controllers for mechanical devices, sensors, signal acquisition, filtering, and conditioning. Microcontroller-based closed-loop control and device communications. Sensor and actuator selection, installation, and application strategies are studied. A term design project is a key component to this course (for 4736).
Prerequisite(s): (ECE 3254 and ME 3514) or (ECE 2004 and ECE 2704)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4736 - Mechatronics (3 credits)
Electromechanical system modeling, control and applications. Design and building of electronic interfaces and controllers for mechanical devices, sensors, signal acquisition, filtering, and conditioning. Microcontroller-based closed-loop control and device communications. Sensor and actuator selection, installation, and application strategies are studied. A term design project is a key component to this course (for 4736).
Prerequisite(s): ME 4735
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4744 - Mechatronics: Theory and Application (4 credits)
Electromechanical design and control applications. Theory, modeling, simulation, analysis, design and building of electronic interfaces and controllers; sensors and actuators; software development, micro-controller technology, and applications. Design Lab/Studio.
Prerequisite(s): ME 3534 and ECE 3254 and (CS 1044 or ECE 1574 or CS 2505)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

ME 4754 - Mechatronics: Advanced Topics and Application (3 credits)
Electromechanical design and control applications. Design and building of electronic interfaces and controllers including sensors, actuators, signal acquisition, filtering, and conditioning for applications. Systems integration with wireless communication; image processing; embedded programs for data acquisition and feedback control applications.
Prerequisite(s): ME 4744
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4764 - Audio Engineering Technology (3 credits)
Principles and design in the field of audio engineering. Loudspeaker design and construction, microphone technology, digital audio acquisition, signal processing in audio engineering, human perception, technical acoustics, binaural hearing, surround sound processing and production, theory, measurement, and reproduction of 3D surround sound, virtual instrument theory and practice, room acoustics and simulation, principles of audio effects (e.g., compression, reverberation, equalization), and acoustic materials engineering.
Prerequisite(s): ME 3524 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4824 - Introduction to Human-Robot Interaction (3 credits)
Formalizing interaction between robots and humans. Developing learning and control algorithms that enable robots to seamlessly and intelligently collaborate with humans. Mathematical approaches to human-robot interaction, learning from demonstration, Bayesian inference, intent detection, safe and optimal control, assistive autonomy, and user study design. Review and present existing literature.
Prerequisite(s): ME 4524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4854 - Nano and Micromechanics of Materials (3 credits)
Analysis of microstructural mechanics, crystal structures, defects, and dislocations. Mechanical behavior of crystalline materials at the microscale. Computational modeling of mechanical behavior in discrete atomistic and molecular systems, including molecular dynamics. Application of these methods to polymers and other soft materials, biological materials, carbon-based materials, and metallic alloys.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4864 - Micro/Nano-Robotics (3 credits)
Overview of Micro/Nano-robotic systems. Physics of reduced length scales (scaling effects in the physical parameters, surface forces, contact mechanics, and Micro/Nano-scale dynamical phenomena), Basics of Micro/Nano-manufacturing, microfabrication and soft lithography, Biomimetic design strategies for mobile micro-robots, Principle of transduction, material properties and characteristics of Micro/Nano-actuators (piezoelectric, shape-memory alloy, and a variety of MEMS and polymer actuators), Control requirements and challenges of Micro/Nano-actuators, Micro/Nano sensors for mobile microrobotic applications, Micro/Nano-manipulation (scanning probe microscopy, operation principles, designing experiments for nanoscale mechanical characterization of desired samples).
Prerequisite(s): ME 3414 and ME 3624 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

ME 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ME 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Meteorology (MTRG)

MTRG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 3524 - Meteorology Field Methods (3 credits)
A field methods course in meteorology. On-location observation and analysis of temperature, wind fields, pressure, and dewpoint. In-field experiences with radar and satellite data, numerical model output and portable weather stations. On-location sites and corresponding curriculum may include severe storm analysis in the Great Plains, mountain weather in the White Mountains (NH) or Rocky Mountains (CO), and costal storms along the Atlantic or Gulf of Mexico coastlines. May be repeated for credit, with permission and different content, for a maximum of 9 hours.
Prerequisite(s): GEOG 2506 and GEOG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MTRG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4584 - Topics in Applied Meteorology (1-3 credits)
Contemporary and emerging theory and praxis in meteorology. Variable topics such as operational weather forecasting situations and scenarios. Identifying common meterological problems and developing pragmatic approaches for solutions. Repeatable with different content for a maximum of six credit hours.
Prerequisite(s): GEOG 1514
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

MTRG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Military Navy (MN)

MN 1004 - Introduction to Naval Science (3 credits)
A basic introduction to the Naval profession and concept of sea power. Explores the role of the commissioned officer and covers uniform regulations, the Uniform Code of Military Justice, Naval terminology, the Oath of Office, the Navy Ethos, and customs and courtesies. Also covers basic communication and the importance of training and qualification. The relationship to sea power and maritime strategy explained through the missions of the Navy and Marine Corps, briefly touching on the mission of other branches. Explains how directives are revised and published, as well as possible threats against platforms. Basic shipboard damage control covered with an emphasis on combating naval casualties.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 1014 - Naval Fitness (1 credit)
Reflects a culture on physical fitness as way of life within the United States Navy & the United States Navy Reserve Officer Training Corps (NROTC). Structured to motivate members to participate and implement year-round physical fitness conditioning program emphasizing total-body wellness to demonstrate expeditionary mission requirements. Prepares midshipmen to demonstrate competency in fitness programs upon entering active duty. Class is limited to students currently enrolled in the Virginia Tech NROTC program. Comprised of evolving content and may be repeated 9 times for a maximum of 10 credit hours. Pre: Enrollment in the Virginia Tech Naval ROTC program.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 10 credit hours

MN 1104 - Naval Ships Systems I: Engineering (3 credits)
Ship characteristics and types. Includes ship design, hydrodynamic forces, stability, main propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. One semester of college level science required.
Prerequisite(s): MN 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 2004 - Naval Ships Systems II: Weapons (3 credits)
Theory and employment of naval weapons systems. Includes threat detection, evaluation, weapon selection, delivery systems, guidance, and warhead design. Elements of command, control, and communications.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 2104 - Seapower and Maritime Affairs (3 credits)
A survey of naval history from the American Revolution to the present with emphasis on major developments in strategy, tactics, and technology. Discussion of the geopolitical theory of Alfred Thayer Mahan. Explores present concerns in seapower and maritime affairs, including the economic and political dimensions of ocean commerce, the Law of the Sea, a comparison of U.S. and Soviet maritime strategies, and current naval affairs.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 3005 - Navigation and Naval Operations (3 credits)
3005: An in-depth study of the theory and practice of piloting and introduction to celestial navigation. Students develop practical skills in the use of charts, visual and electronic aids. A study of the International Rules of the Nautical Road. 3006: Relative motion, vector-analysis theory, and ship employment. Includes an introduction to naval operations, ship characteristics, shiphandling, and afloat communications. I
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 3006 - Navigation and Naval Operations (3 credits)
3005: An in-depth study of the theory and practice of piloting and celestial navigation. Students develop practical skills in the use of charts, visual and electronic aids. 3006: A study of the International Rules of the Nautical Road, relative motion, vector-analysis theory, and ship employment. Includes an introduction to naval operations, ship characteristics, shiphandling, and afloat communications. II
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 3204 - Evolution of Warfare (3 credits)
Development of warfare focusing on impact of major military theorists, strategists, and technicians. Ancient times to present. I
Prerequisite(s): MN 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4005 - Leadership and Management/Ethics (3 credits)
4005: Examines leadership skills, strategies, and contexts as interpreted through the lenses of the leader, the follower, and the situation. Contrasts the roles of leader and manager within diverse constructs. Focuses on building and sustaining high-performance teams through transformational, charismatic and servant leadership. Challenges students to develop individual leadership skill development programs. Introduces general ethical theories and moral reasoning skills in the context of ethical decision making case studies, dark side trait analysis, and associated mitigation strategies. 4006: Explores philosophical schools of ethical thought in the context of targeted/representative case studies, both historical and contemporary in nature. Applies theoretical approaches to moral reasoning specifically as they pertain to ethical dilemmas within the rubrics of distributive justice and just war theory. Analyzes moral obligations as entailed by a voluntary oath of service. Examines strategies for mentorship, behavior reinforcement, and disciplinary options to optimize organizational success. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4006 - Leadership and Management/Ethics (3 credits)
4005: Examines leadership skills, strategies, and contexts as interpreted through the lenses of the leader, the follower, and the situation. Contrasts the roles of leader and manager within diverse constructs. Focuses on building and sustaining high-performance teams through transformational, charismatic and servant leadership. Challenges students to develop individual leadership skill development programs. Introduces general ethical theories and moral reasoning skills in the context of ethical decision making case studies, dark side trait analysis, and associated mitigation strategies. 4006: Explores philosophical schools of ethical thought in the context of targeted/representative case studies, both historical and contemporary in nature. Applies theoretical approaches to moral reasoning specifically as they pertain to ethical dilemmas within the rubrics of distributive justice and just war theory. Analyzes moral obligations as entailed by a voluntary oath of service. Examines strategies for mentorship, behavior reinforcement, and disciplinary options to optimize organizational success. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4204 - Amphibious Warfare (3 credits)
Historical survey of the development of amphibious doctrine and the conduct of amphibious operations. Emphasis is on amphibious operations in World War II. Present day potential and limitations on amphibious operations are explored. I
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 4984 - Special Study (1-19 credits)
II
Instructional Contact Hours: Variable credit course

Military Sciences (AROTC) (MS)

MS 1005 - Military Science I, Army Reserve Officer Training Corps (2 credits)
First year of military science. MS 1005: Introduction to the Army introduces the personal challenges and competencies that are critical for effective leadership and communication. Student learning focuses on developing individual and interactive skills. Students learn how cultural understanding, goal setting, time management, stress management, and comprehensive fitness relates to leadership and the Army profession. Students further learn the ROTC course structure and progression, and are immersed into Army organizational culture via classroom instruction, physical fitness training, and leadership labs. MS 1006: Foundations of Agile and Adaptive Leadership introduces students to basic knowledge required to be a successful member of a military team, to include the U.S. Armys mission, its role and relationship in the American governance system, U.S. military customs and courtesies, operational terms and graphics, map reading, land navigation squad tactics, the Army Values and Warrior Ethos. This course includes reading assignments, homework assignments, practical exercises, a mid-term exam, and a final exam. Students receive systematic and specific feedback on leader attributes, values, and core leader competencies throughout the course. Successful completion of this course will help prepare cadets for Military Sci II, AROTC.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MS 1006 - Military Science I, Army Reserve Officer Training Corps (2 credits)
First year of military science. MS 1005: Introduction to the Army introduces the personal challenges and competencies that are critical for effective leadership and communication. Student learning focuses on developing individual and interactive skills. Students learn how cultural understanding, goal setting, time management, stress management, and comprehensive fitness relates to leadership and the Army profession. Students further learn the ROTC course structure and progression, and are immersed into Army organizational culture via classroom instruction, physical fitness training, and leadership labs. MS 1006: Foundations of Agile and Adaptive Leadership introduces students to basic knowledge required to be a successful member of a military team, to include the U.S. Armys mission, its role and relationship in the American governance system, U.S. military customs and courtesies, operational terms and graphics, map reading, land navigation squad tactics, the Army Values and Warrior Ethos. This course includes reading assignments, homework assignments, practical exercises, a mid-term exam, and a final exam. Students receive systematic and specific feedback on leader attributes, values, and core leader competencies throughout the course. Successful completion of this course will help prepare cadets for Military Sci II, AROTC.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MS 2005 - Military Science II, Army Reserve Officer Training Corps (3 credits)
Second year of military science. 2005: Troop Leading Procedures focuses on operations order production, leadership principles and styles, ethical and moral reasoning, land navigation and intermediate squad and platoon tactics. Required participation: leadership lab, physical training and field training exercises. 2006: Unified Land Operations focuses on doctrine and symbology, principles of joint operations, intermediate small unit tactics and leadership, effective communication, team building, counseling and coaching methods, code of conduct and law of land warfare. Required participation: leadership lab, physical training and field training exercises.
Prerequisite(s): MS 1005 and MS 1006
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MS 2006 - Military Science II, Army Reserve Officer Training Corps (3 credits)
Second year of military science. 2005: Troop Leading Procedures focuses on operations order production, leadership principles and styles, ethical and moral reasoning, land navigation and intermediate squad and platoon tactics. Required participation: leadership lab, physical training and field training exercises. 2006: Unified Land Operations focuses on doctrine and symbology, principles of joint operations, intermediate small unit tactics and leadership, effective communication, team building, counseling and coaching methods, code of conduct and law of land warfare. Required participation: leadership lab, physical training and field training exercises.
Prerequisite(s): MS 1006
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 3005 - Military Science III, Army Reserve Officer Training Corps (4 credits)
Third year of military science. 3005: Training management and the warfighting functions focuses on unified land operations, troop leading procedures, operations order production, written and oral communication, training management, squad leadership and tactics, squad and platoon offense/defense, land navigation, after action reviews, leadership, and physical training. Required participation: leadership lab, physical training and field training exercises. 3006: Applied leadership in small unit operations, squad and platoons offense/defense, basic rifle marksmanship, written and oral communication, land navigation, fires support to dismounted operations, leadership, physical training and preparation for advanced camp. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 2005 and MS 2006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 3006 - Military Science III, Army Reserve Officer Training Corps (4 credits)
Third year of military science. 3005: Training management and the warfighting functions focuses on unified land operations, troop leading procedures, operations order production, written and oral communication, training management, squad leadership and tactics, squad and platoon offense/defense, land navigation, after action reviews, leadership, and physical training. Required participation: leadership lab, physical training and field training exercises. 3006: Applied leadership in small unit operations, squad and platoons offense/defense, basic rifle marksmanship, written and oral communication, land navigation, fires support to dismounted operations, leadership, physical training and preparation for advanced camp. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 2005 and MS 2006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4005 - Military Science IV, Army Reserve Officer Training Corps (4 credits)
Fourth year of military science. 4005: The Army Officer focuses on development of the Army officer. It is an academically challenging course where students develop knowledge, skills, and abilities to plan, resource, and assess training at the small unit level. Students learn about Army programs that support counseling subordinates and evaluating performance, applying values and ethics to organizational problems, career planning, and legal responsibilities. Required participation: leadership lab, physical training and field training exercises. 4006: Company Grade Leadership focuses on preparing students to fulfill key leadership roles at the company level. This is an academically challenging course where students study, practice, develop, and apply critical thinking skills pertaining to Army leadership, officer skills, Army values and ethics, personal development, small unit tactics, platoon level leadership. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 3006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4006 - Military Science IV, Army Reserve Officer Training Corps (4 credits)
Fourth year of military science. 4005: The Army Officer focuses on development of the Army officer. It is an academically challenging course where students develop knowledge, skills, and abilities to plan, resource, and assess training at the small unit level. Students learn about Army programs that support counseling subordinates and evaluating performance, applying values and ethics to organizational problems, career planning, and legal responsibilities. Required participation: leadership lab, physical training and field training exercises. 4006: Company Grade Leadership focuses on preparing students to fulfill key leadership roles at the company level. This is an academically challenging course where students study, practice, develop, and apply critical thinking skills pertaining to Army leadership, officer skills, Army values and ethics, personal development, small unit tactics, platoon level leadership. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 3005 and MS 3006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Military, Aerospace Studies (AS)

AS 1115 - Introduction to the Air Force (1 credit)
Introduction to the United States Air Force and Air Force Reserve Officer Training Corps. Mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and introduction to communication skills.
Corequisite(s): AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 1116 - Introduction to the Air Force (1 credit)
Introduction to the United States Air Force and Air Force Reserve Officer Training Corps. Mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and introduction to communication skills.
Corequisite(s): AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2115 - Team and Leadership Fundamentals (1 credit)
A fundamental understanding of both leadership and team building. 2115: Followership, motivation, listening, problem solving, full-range leadership, standards and accountability, self-assessment, oral and written communication, and financial readiness of an Air Force officer. 2116: Human relations, team building models, ethical decision making, stress management and resiliency, and conflict resolution.
Prerequisite(s): AS 1115 and AS 1116
Corequisite(s): AS 2934, AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2116 - Team and Leadership Fundamentals (1 credit)
A fundamental understanding of both leadership and team building. 2115: Followership, motivation, listening, problem solving, full-range leadership, standards and accountability, self-assessment, oral and written communication, and financial readiness of an Air Force officer. 2116: Human relations, team building models, ethical decision making, stress management and resiliency, and conflict resolution.
Prerequisite(s): AS 2115
Corequisite(s): AS 2934, AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2934 - Air Force Fitness (1 credit)
Reflects change in culture on physical fitness and incorporates fitness as a way of life with the United States Air Force & the Air Force Reserve Officer Training Corps (AFROTC). Structured to motivate members to develop and maintain year-round physical fitness conditioning program emphasizing total-body wellness to meet expeditionary mission requirements. Prepares cadets to tackle squadron fitness programs upon entering active duty. Course may be taken up to 10 times. Pre-requisite: Enrollment on AFROTC
Corequisite(s): AS 2944
Instructional Contact Hours: (2 Lec, 1 Crd)
Repeatability: up to 10 credit hours

AS 2944 - AFROTC Leadership Laboratory (1 credit)
Experiential learning laboratory that allows cadets to practice and demonstrate mastery of leadership skills essential to an Air Force officer. May be taken eight times. Membership in Virginia Tech Corps of Cadets required.
Corequisite(s): AS 1115, AS 1116, AS 2115, AS 2116, AS 3215, AS 3216, AS 4215, AS 4216
Instructional Contact Hours: (4 Lab, 1 Crd)
Repeatability: up to 8 credit hours

AS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 3215 - Air Force Management and Leadership (3 credits)
Integrated leadership study emphasizing concepts and skills. Motivational and behavioral processes, management, military ethics, communication, and group dynamics. Examines case studies and scenarios.
Prerequisite(s): AS 2116
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 3216 - Air Force Management and Leadership (3 credits)
Integrated leadership study emphasizing concepts and skills. Motivational and behavioral processes, management, military ethics, communications, and group dynamics. Examines case studies and scenarios.
Prerequisite(s): AS 2116
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4215 - National Security Forces in Contemporary American Society (3 credits)
Examines the formulation, organization, and implementation of national security; evolution of strategy; management of conflict; and civil-military interaction. Military profession, officership, and the military justice system. Air Force communication skills.
Prerequisite(s): AS 3216
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4216 - National Security Forces in Contemporary American Society (3 credits)
Examines the formulation, organization, and implementation of national security; evolution of strategy; management of conflict; and civil-military interaction. Military profession, officership, and the military justice system. Air Force communications skills.
Prerequisite(s): AS 3216
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Mining and Minerals Engineerin (MINE)

MINE 1024 - Leadership and Service in the Mineral Industries (1 credit)
Leadership and service principles. Awareness of self and others through personality typing. Strategic planning. Importance of energy and mineral industries to developed and developing countries as well as associated consequences. Mineral extraction and purification processes and calculations. Conflict resolution. Challenges and opportunities available in the energy and mineral industries. May include guest speakers and field trips.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1034 - Automation and Data Analytics in the Mineral Industries (1 credit)
Discovering challenges and opportunities available in autonomous vehicles, systems, and data analytics associated with the energy and mineral industries. Fundamentals of robotics and data analytics; hands on projects with autonomous kits and drones; analysis of industry data, including production studies; introduction to presentation of complex data in a simplified manner; introduction to simulations and digital twins.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1044 - Space Mining (1 credit)
Explore challenges and opportunities in off-earth mining. Resources currently identified on earth and critical uses; astroidal, lunar, and martian resources; operating conditions in space; environmental, social, and governance issues; economic drivers; in situ resource utilization.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2114 - Energy and Raw Materials: Geopolitics and Sustainable Development (3 credits)
Supply and demand of energy resources and raw materials. Domestic and global trends. Development of energy and mineral resources. Electricity generation, efficiency, and distribution. Energy and raw materials infrastructure Disparities in resource-producing vs. resource-consuming regions. Environmental considerations and engineering management. Land use and reclamation. Greenhouse gas management. Policy, regulations, and incentives. Geopolitical considerations. Conservation and efficiency. Sustainable development. This course is available to undergraduate students of all ranks and all majors.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2504 - Introduction to Mining Engineering (3 credits)
Introduction to the complete field of mining and minerals engineering, including phases of mine development, discreet mining methods and mineral processing operations. Consideration in unconventional oil and gas development. Emphasis on basic engineering problem solving skills, and considerations for worker health and safety, economics, and environmental and social issues.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2524 - Elements of Mine Design (3 credits)
Basic concepts used in the modeling and design of mining systems including basic statistical concepts, sampling, geological and geostatistical modeling of ore bodies, ore reserve estimation, and selection of basic mine development methods.
Prerequisite(s): MINE 2504 and GEOS 1004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2534 - Mine Surveying and Mapping (3 credits)
Specialized principles of field surveying and mapping as applied to the delineation of mineral deposits and the design and monitoring of surface and underground mining operations. Introduction to modern surveying instruments, field techniques, and computational procedures. Basic digital mine mapping to include standard mine symbols and representation of surface and underground mine workings. Partially duplicates ENGE 2824.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2544 - Leadership for Responsible Mining (2 credits)
Principles of leadership for the global resource industries including identification of project impacts and risks, stakeholder analysis and conflict management. Emphasis on engineering ethics and effective communications. Sustainable development of mineral and energy resources, with focus on emerging technical, economic, environmental and social issues in the US and abroad.
Prerequisite(s): ENGL 1106
Corequisite(s): MINE 2504
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 2564 - Resource Exploration and Design (3 credits)
Basic methods and concepts in exploration and modeling of ore bodies. Resource exploration planning. Exploration technologies for potential mine sites. Design of mining systems. Computational modeling of ore bodies and mine systems. Environmental, regulatory, ethical, and social considerations in mine system design.
Prerequisite(s): GEOS 1004
Corequisite(s): MINE 2504
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2714 - Introduction to Petroleum and Natural Gas Engineering (3 credits)
Introduction to basics of petroleum and natural gas engineering. Concepts of conventional and unconventional fossil fuel energy; basics of rock mechanics and reservoir fluid properties. Concepts of drilling and completion engineering. Concepts of hydraulic fracturing; basic knowledge of formation evaluation and various rock types. Basics of geophysical monitoring methods; basics of different oil and gas reservoirs; basics of production engineering and fundamentals of recovery mechanisms, discussion of petroleum and natural gas social and policy issues.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 3544 - Mineral Processing Laboratory (1 credit)
Laboratory investigations of the unit operations and principles of mineral processing including ore preparation (size reduction, mineral liberation, and classification) and mineral recovery (froth flotation, electrostatic separation, magnetic separation, and solid-liquid separation).
Prerequisite(s): MINE 3534
Corequisite(s): MINE 3554
Instructional Contact Hours: (3 Lab, 1 Crd)

MINE 3564 - Underground Mine Design (3 credits)
Design fundamentals of mining systems and stope development for tabular and massive underground mineral deposits. Equipment selection and application, permitting, cost analysis and production simulation.
Prerequisite(s): MINE 2564 and MINE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3574 - Surface Mine and Quarry Design (3 credits)
Surface mining methods, and their selection; mine planning and design; excavation, haulage and ancillary systems; equipment selection and maintenance; impoundment and piles design; mine closure/reclamation.
Prerequisite(s): MINE 2564 and MINE 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3584 - Ventilation Engineering (3 credits)
Subsurface ventilation systems. Ventilation planning and design, laws of airflow, airway resistance. Ventilation surveys, network analysis, ventilation economics. Ventilation software. Fan types, impeller theory, fan laws and testing. Mine ventilation thermodynamics.
Prerequisite(s): MINE 2504
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3604 - Mining Geomechanics (3 credits)
Properties and behavior of geologic materials and masses and their classifications and ratings. Design principles of structures founded on and in rocks and basic aspects of ground control in mining. Laboratory techniques used in the determination of geologic materials properties and behavior. Determination of rock index properties, strengths, failure criterion and mechanical behavior.
Prerequisite(s): MINE 2504 and GEOS 1004 and ESM 2204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3624 - Mineral Resource Project Management (3 credits)
Applied and theoretical concepts in the valuation and management of mining and energy extraction projects. Project engineering, resource management, scheduling, and tracking. Estimation of capital costs, operating costs, and revenues for underground and surface mines, mineral beneficiation plants, and oil and gas ventures. Commodity sales contracts and price projections. Cash flow analysis, revenue-generating and service producing alternative selection, taxes/deductions. Quantitative risk analysis including stochastic simulation. Environmental, ethical, and legal considerations in project management.
Prerequisite(s): MINE 2504 and MINE 2564
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3634 - Fundamentals of Mineral Processing (3 credits)
Principles of mineral processing with an emphasis on metallurgical data evaluation, unit operations, and flowsheet configurations. Metallurgical accounting, slurry calculations, grade-recovery relationships, chemical aspects of mineral processing, and particle size analysis. Unit operations including rushing, grinding, size separation, gravity separation, magnetic and electrostatic separation, froth dewatering. Laboratory investigations of the unit operations and principles of mineral processing.
Prerequisite(s): MINE 2504 and GEOS 1004 and CHEM 1035
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3644 - Applications in Mineral Processing (2 credits)
Applied concepts in the design and operation of mineral processing plants. Flowsheet engineering, unit selection, unit sizing, water/mass flow balancing, simulation, process control, and cost estimation. Environmental, economic, and legal considerations in process plant design.
Prerequisite(s): MINE 3634
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 3664 - Fluids and Thermodynamics for Resources (3 credits)
Fluid properties and hydrostatics. Derivation and application of the continuity, momentum, and energy equation (Bernoulli's equation) for ideal and real fluid flow (laminar or turbulent). Properties of pure substances: property tables, property software, equations of state. First law of thermodynamics. Second law of thermodynamics. Gas mixtures. Applications in the resource extraction industries.
Prerequisite(s): ESM 2304 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3674 - Explosives and Rock Fragmentation (3 credits)
Rock fragmentation for excavation; drilling fragmentation, rock drilling systems; blasting fragmentation, types and properties of commercial explosives and accessories, system of initiation, design of blasting rounds, applications in mining and construction, structural damage criteria, overbreak control, safe practice and regulations; fragmentation by excavation machines; excavation system selection and design.
Prerequisite(s): MINE 2504 and GEOS 1004 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3714 - Petroleum and Natural Gas Reservoir Engineering (3 credits)
Introduction to oil and gas reservoirs; basics of reservoir rock and fluid properties; fundamentals of different petroleum reservoirs; determination of oil and gas in place; material balance equation; prediction of transient pressure distribution; prediction of saturation distribution; basics of recovery mechanisms; single and multiphase flows in petroleum reservoirs; and prediction of recovery factor and production rate.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3724 - Formation Evaluation and Engineering (3 credits)
Well log measurements and interpretation; standard logging suites used in industry; core sampling methods and laboratory analysis; relationship of well data to seismic and other geophysical data; relationship of well-derived reservoir properties to reservoir estimation calculations, well completions strategies, and development strategies.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4504 - Materials Handling and Power Systems (3 credits)
Principles of materials handling, fluid power and electrical power systems for surface and underground mining operations. Engineering analysis and design of secondary haulage operations (belt conveyors, hoists, trucks, railways), fluid power systems (hydraulics, pumps, piping networks, compressors, pneumatic equipment). Electrical systems (electrical machinery, distribution networks, controls), and other ancillary systems required to support mining operations. Assessment of equipment reliability and development of preventive maintenance programs.
Prerequisite(s): ESM 3024
Corequisite(s): ECE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4614 - Health and Safety Systems (3 credits)
Investigation of health and safety management systems. Study of mine legislation; data analysis of accidents; hazard identification; risk management; training programs; emergency response plans.
Prerequisite(s): MINE 3564 or MINE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4624 - Mine and Water Reservoir Engineering (3 credits)
Essential topics related to water in resource extraction projects, including surface and ground water hydrology, chemistry and treatment of mine-influenced waters and waters from unconventional oil and gas production, and mine dewatering. Emphasis on basic design calculations and modeling.
Prerequisite(s): MINE 3664 and (MINE 3564 or MINE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4635 - Mining Engineering Capstone (2 credits)
4635: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. 4636: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. Culminates in the preparation of a technical report that describes the commercial development, extraction and closure of a mineral deposit under global reporting standards, and provides detailed operational layouts, production calculations, and engineering cost analyses.
Prerequisite(s): MINE 2544 and (MINE 3564 or MINE 3574) and MINE 3624
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4636 - Mining Engineering Capstone (2 credits)
4635: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. 4636: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. Culminates in the preparation of a technical report that describes the commercial development, extraction and closure of a mineral deposit under global reporting standards, and provides detailed operational layouts, production calculations, and engineering cost analyses.
Prerequisite(s): MINE 4635
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4644 - Environmental Management for Mining and Geoenergy (2 credits)
Environmental impacts of mines and geoenergy resource development projects, including water, land and air pollution. Statutory and regulatory environmental requirements, with an emphasis on permitting, monitoring and compliance. Best practices for environmental management systems.
Prerequisite(s): MINE 3564 or MINE 3574
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4654 - Mine Power Systems and Automation (3 credits)
Fundamentals of electrical theory. Circuit elements, calculations and network analysis. Components and design of mine power systems. Motors, cables, load flow analyses, transmission and distribution. Electrical safety. U.S. mine-specific regulation, intrinsic safety and permissibility. Applications in mine systems automation via programmable logic control. Basic ladder logic routines.
Prerequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4664 - Resource Engineering Leadership Seminar (1 credit)
Invited speakers and subject experts, assigned readings, facilitated activities and discussions, personality and values assessment, learning taxonomy and learning styles, diversity in the workplace, implications of personal differences for workplace and leadership dynamics, strategies and best practices for effective leadership, oral and written communication for diverse audiences. Pre: Senior Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 4714 - Well Drilling and Completion Engineering (3 credits)
Introduction to drilling and completion design; functions of drilling fluids; wellbore hydraulics and drilling bits; principles of well control; casing design; design of cementing jobs; directional drilling in conventional and unconventional formations, completions.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4724 - Petroleum and Natural Gas Production Engineering (3 credits)
Extraction of reservoir fluids; oil and gas thermodynamic properties; phase behavior of petroleum fluids; analysis of surface production facilities; fluid separation; processing of reservoirs fluids; fluid disposal in an environmentally acceptable manner; surface transportation systems; separator design; design of artificial lift systems.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Music (MUS)

MUS 1004 - School of Performing Arts First Year Experience (1 credit)
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the Schools programs. Foster a sense of community and understanding across disciplines.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: TA 1004

MUS 1005 - Theory Fundamentals (3 credits)
Fundamental elements of music theory. 1005: Introduction to elements of music theory. Musical notation, scales of various global traditions, foundations of tonality; intervals, triads, dominant seventh chords, rhythm, meter, cadences, harmonic analysis. Composition with species counterpoint and the twelve-bar blues progression. Aural recognition of musical sounds through ear training. 1006: More complex harmonic and rhythmic processes. Increase complexity of intervals, chords, rhythms, progressions and score reading. Introduce transposition and vocabulary for timbre and textural discussion. Aural recognition of more advanced musical sounds through ear training. Fluency in terms and conventions for western art music, rock, hip-hop. Composition of original music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1006 - Theory Fundamentals (3 credits)
Fundamental elements of music theory. 1005: Introduction to elements of music theory. Musical notation, scales of various global traditions, foundations of tonality; intervals, triads, dominant seventh chords, rhythm, meter, cadences, harmonic analysis. Composition with species counterpoint and the twelve-bar blues progression. Aural recognition of musical sounds through ear training. 1006: More complex harmonic and rhythmic processes. Increase complexity of intervals, chords, rhythms, progressions and score reading. Introduce transposition and vocabulary for timbre and textural discussion. Aural recognition of more advanced musical sounds through ear training. Fluency in terms and conventions for western art music, rock, hip-hop. Composition of original music.
Prerequisite(s): MUS 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1104 - Music Appreciation (3 credits)
Survey of the art of music encompassing a variety of music styles and historical eras in both the western and non- western world. Students will develop strategies to contextualize music, via listening, from the perspective of the listener, composer, and performer.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1114 - Listening in the Digital Age (3 credits)
An introduction to musical access and listening in the digital age. Introduces basic elements of music and the creative process together with important musicians and their works. Explores historical, social, and cultural forces and trends that influence the creation and interpretation of various musical styles, including classical, blues, jazz, popular, and world music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1124 - Living a Musical Life (3 credits)
Embrace a wide variety of music and ways to make music. Learn about the health benefits of lifelong music-making. Units include regional, national, and international traditions in historical, political, and cultural contexts. No prior musical training required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1134 - Music of the Americas (3 credits)
Musical traditions in the American continent, with a specific focus on Latin-American and Latinx musics. Introduction to music from different traditions across nations and social-historical contexts. Critical engagement with broad social concepts from cultural, political, and historical perspectives. Development of listening and writing skills.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2025 - European-American Music Theory (3 credits)
Fundamental elements of music and conventions of genre and style in a global context. 2025: pitch & harmony, rhythm & meter, timbre, texture, and movement. Emphasis on rote learning of pitch notation, intervals, key signatures, chords vs non-chord tones, and pitch collections. Methods to analyze harmony, phrase structure, and meter. Develop vocabulary for timbre and texture. Basic skills of score reading and transposition. 2026: form, as well as more complex harmonic and rhythmic processes, such as harmonic rhythm, syntax and metric dissonance. Increase complexity of score reading to include larger ensembles. In-depth study of genre, considering elements of harmony, rhythm & meter, and form in European and North-American classical, jazz, and popular musics.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2026 - European-American Music Theory (3 credits)
Fundamental elements of music and conventions of genre and style in a global context. 2025: pitch & harmony, rhythm & meter, timbre, texture, and movement. Emphasis on rote learning of pitch notation, intervals, key signatures, chords vs non-chord tones, and pitch collections. Methods to analyze harmony, phrase structure, and meter. Develop vocabulary for timbre and texture. Basic skills of score reading and transposition. 2026: form, as well as more complex harmonic and rhythmic processes, such as harmonic rhythm, syntax and metric dissonance. Increase complexity of score reading to include larger ensembles. In-depth study of genre, considering elements of harmony, rhythm & meter, and form in European and North-American classical, jazz, and popular musics.
Prerequisite(s): MUS 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2045 - Sightsinging Laboratory (1 credit)
Study and practice of techniques involved in the sight reading and sightsinging of printed music. Majors and minors only.
Corequisite(s): MUS 2025
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2046 - Sightsinging Laboratory (1 credit)
Study and practice of techniques involved in the sight reading and sightsinging of printed music. Majors and minors only.
Prerequisite(s): MUS 2045
Corequisite(s): MUS 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2054 - Introduction to Music Technology (2 credits)
History, theory, and applications of music technology. Techniques for notating music and for recording and editing audio, using computer software and digital audio equipment. Consent Required. Design lab.
Instructional Contact Hours: (3 Lab, 2 Crd)

MUS 2055 - Audio Technology For Music (3 credits)
Develops basic understanding of audio technology for musical applications, focusing on todays digital audio recording and editing technologies including microphone use, live recording, and studio session recording. Develops critical listening skills through lab experimentation and recording. Pre: 2054 and permission of instructor required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2056 - Audio Technology For Music (3 credits)
Develops basic understanding of audio technology for musical applications, focusing on todays digital audio recording and editing technologies including microphone use, live recording, and studio session recording. Develops critical listening skills through lab experimentation and recording. Pre: 2054 and permission of instructor required.
Prerequisite(s): MUS 2055
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2065 - Music Composition (2 credits)
Organizing the basic elements of music: pitch, rhythm, timbre, articulation, and dynamics. Composing pieces for solo instruments and duos. Preparing scores and parts, for performances and recordings of the compositions. Knowledge of basic music theory required. Consent Required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2066 - Music Composition (2 credits)
Composing for specific instruments and combinations of instruments. Exploring traditional and extended technique. Organizing the structure of a piece based on recurrence, development, variation, priority, and perspective of musical material, for trio adn quartet or a larger ensemble. A grade of C or better in prerequisite.
Prerequisite(s): MUS 2065
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2115 - Survey of Western Music (3 credits)
Survey and study of the historical evolution of Western art music. MUS 2115: classical music from Antiquity into the Classical era. MUS 2116: classical and other music from the Romantic era through the 20th century to music of today. Investigation of the materials of music. Exploration of music as it both reflects and impacts history, including historical considerations of gender, race, culture, and other extramusical factors. Relevance of historical and contemporary music to our society today.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2116 - Survey of Western Music (3 credits)
Survey and study of the historical evolution of Western art music. MUS 2115: classical music from Antiquity into the Classical era. MUS 2116: classical and other music from the Romantic era through the 20th century to music of today. Investigation of the materials of music. Exploration of music as it both reflects and impacts history, including historical considerations of gender, race, culture, and other extramusical factors. Relevance of historical and contemporary music to our society today.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2124 - Music Traditions in Appalachia (3 credits)
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 2124

MUS 2134 - Disability Culture & the Arts (3 credits)
Disability as an identity, community, and culture through a study of music and the arts. Overview of the disability rights and disability justice movements in the United States, as told through music, film, literature, and performance art. Analyze creative works, confront obstacles to inclusion, and discover disability cultural values. No previous musical training required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2214 - Class Applied Piano (1 credit)
Group piano lessons for beginners or for students at an early stage of keyboard development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2224 - Class Applied Voice (1 credit)
Group voice lessons for beginners or for students at an early stage of vocal development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2234 - Class Applied Strings (1 credit)
Group string lessons for beginners or for students at an early stage of string development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2244 - Class Applied Woodwinds (1 credit)
Group woodwind lessons for beginners or for students at an early stage of woodwind development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2254 - Class Applied Brass (1 credit)
Group brass lessons for beginners or for students at an early stage of brass development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2264 - Class Applied Percussion (1 credit)
Group percussion lessons for beginners or for students at an early stage of development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2274 - Music Education Lab Ensemble (1 credit)
Music education laboratory ensemble. Performance techniques, teaching methods, management procedures, materials and literature for school music ensembles. May be repeated for credit.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2284 - Piano Accompanying (2 credits)
Examine and practice the skills necessary for successful piano accompanying. Develop keyboard skills such as sightreading, transposition, choral score reading, and harmonization. Learn principles of accompanying vocal repertoire, instrumental repertoire, including large ensemble repertoire; adapt orchestral reductions for piano. Instructor consent required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2314 - Woodwind Techniques I - Flute, Clarinet, Saxophone (1 credit)
Instruction in basic performing skills and practices for woodwind instruments (flute, clarinets, saxophone). Study of pedagogy for woodwind instruction in K-12 music education settings. Survey of repertoire, resources, and materials for use in woodwind instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2324 - Woodwind Techniques II - Oboe and Bassoon (1 credit)
Instruction in basic performing skills and practices for woodwind instruments (oboe, bassoon). Study of pedagogy for woodwind instruction in K-12 music education settings. Survey of repertoire, resources, and materials for use in woodwind instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2334 - High Brass Techniques (1 credit)
Instruction in basic performing skills and practices for high brass instruments (trumpet and horn). Study of pedagogy for teaching brass in K-12 music education settings. Survey of repertoire, resources, and materials for use in brass instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2344 - Low Brass Techniques (1 credit)
Instruction in basic performing skills and practices for low brass instruments (trombone, euphonium, and tuba). Study of pedagogy for teaching brass in K-12 music education settings. Survey of repertoire, resources, and materials for use in brass instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2364 - Introduction to Music Education (2 credits)
Principles and practices fundamental to music learning and teaching. Philosophical bases for teaching music. Major educational learning theories (e.g., behaviorism, cognitivism, social constructivism, multiple intelligences, spiral learning theory, Bloom's taxonomy, etc.). Pedagogical approaches, culturally responsive teaching, and technology integration in the music classroom. Field observation for real world public-school music instruction.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2514 - Individual Applied Voice (1-3 credits)
Individual instruction in voice. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2515 - Vocal Diction (1 credit)
An introduction to principles of vocal diction for singing using the International Phonetic Alphabet and standard foreign-language pronunciation techniques.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2516 - Vocal Diction (1 credit)
An introduction to principles of vocal diction for singing using the International Phonetic Alphabet and standard foreign-language pronunciation techniques.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2524 - Individual Applied Keyboard (1-3 credits)
Individual instruction in keyboard. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2534 - Individual Applied Violin (1-3 credits)
Individual instruction in violin. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2544 - Individual Applied Viola (1-3 credits)
Individual instruction in viola. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2554 - Individual Applied Cello (1-3 credits)
Individual instruction in cello. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2564 - Individual Applied Bass (1-3 credits)
Individual instruction in bass. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2574 - Individual Applied Flute (1-3 credits)
Individual instruction in flute. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2584 - Individual Applied Oboe (1-3 credits)
Individual instruction in oboe. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2594 - Individual Applied Clarinet (1-3 credits)
Individual instruction in clarinet. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2604 - Introduction to Arts Marketing (3 credits)
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field, and direct hands-on experience.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: TA 2604

MUS 2614 - Individual Applied Saxophone (1-3 credits)
Individual instruction in saxophone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2624 - Individual Applied Bassoon (1-3 credits)
Individual instruction in bassoon. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2634 - Individual Applied Horn (1-3 credits)
Individual instruction in horn. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2644 - Individual Applied Trumpet (1-3 credits)
Individual instruction in trumpet. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2654 - Individual Applied Trombone (1-3 credits)
Individual instruction in trombone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 2664 - Individual Applied Baritone (1-3 credits)
Individual instruction in baritone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2674 - Individual Applied Tuba (1-3 credits)
Individual instruction in tuba. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2684 - Individual Applied Percussion (1-3 credits)
Individual instruction in percussion. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2734 - Individual Applied Composition (1-3 credits)
Individual instruction in composition. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2754 - Individual Applied Recording (1-3 credits)
Individual instruction through directed experiential learning of music recording and production. Integration of critical listening, acoustics, audio recording, and signal processing with music theory and performance. An emphasis on hands-on exploratory research in the use of instruments, acoustics, and microphone techniques combined with traditional methods and emerging technologies to capture and produce recordings of musical performances and works in a natural and effective manner. Permission required. May be repeated for a maximum of 8 hours.
Prerequisite(s): MUS 2055
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 8 credit hours

MUS 2815 - Jazz Improvisation (2 credits)
Fundamental principles of jazz improvisation. Topics include interval relationships, chord identification, modes and modality, blues and ii-V-I chord progressions. Pre: Permission of instructor required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2816 - Jazz Improvisation (2 credits)
Fundamental principles of jazz improvisation. Topics include interval relationships, chord identification, modes and modality, blues and ii-V-I chord progressions. Pre: Permission of instructor required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 3024 - Counterpoint (3 credits)
Study of the development and aesthetics of contrapuntal techniques throughout the common practice period.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3025 - European-American Music Analysis (3 credits)
Extended compositional techniques in late-nineteenth and twentieth-century music, and analysis of larger works. 3025: chromatic harmony, twentieth-century techniques of pitch organization (e.g., set theory), grouping and displacement dissonance, large-scale musical forms. Analysis complemented by model composition and performance to demonstrate mastery of theoretical concepts and stylistic competency. 3026: synthesis of analytical techniques while navigating musical ambiguity in complete works of various sizes (miniatures to multi-part). Analytical observations connected to expressive or narrative meaning in musics from various styles and genres. Refine ability to write about music through research project.
Prerequisite(s): MUS 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3026 - European-American Music Analysis (3 credits)
Extended compositional techniques in late-nineteenth and twentieth-century music, and analysis of larger works. 3025: chromatic harmony, twentieth-century techniques of pitch organization (e.g., set theory), grouping and displacement dissonance, large-scale musical forms. Analysis complemented by model composition and performance to demonstrate mastery of theoretical concepts and stylistic competency. 3026: synthesis of analytical techniques while navigating musical ambiguity in complete works of various sizes (miniatures to multi-part). Analytical observations connected to expressive or narrative meaning in musics from various styles and genres. Refine ability to write about music through research project.
Prerequisite(s): MUS 3025
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3034 - Form and Analysis in the Common-practice Period (3 credits)
Domains of rhythm and meter, harmony, and cadence as related to musical form. Score-based and aural analysis of formal functions of common theme-types and large-scale forms in selected works from the mid-eighteenth through nineteenth centuries using William Caplin's theory. Identification of deviations from stylistic norms. Analysis complemented by model composition to demonstrate mastery of theoretical concepts and stylistic competency.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3035 - Advanced Class Piano (1 credit)
Develop keyboard skills such as sightreading, harmonization, transposition, learn all scales/arpeggios and important keyboard progressions. A grade of C or better required in prerequisite.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3036 - Advanced Class Piano (1 credit)
Continued development of keyboard skills. Advanced transposition, harmonization, and sightreading, open score reading, and real-world application of skills acquired throughout keyboard study. A grade of C or better required in prerequisite.
Prerequisite(s): MUS 3035
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3044 - Orchestration & Analysis (3 credits)
An introduction to the craft of scoring and arranging of music for full orchestra. Analysis of scores, small projects and a full orchestration project.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3045 - Advanced Ear Training (1 credit)
3045: Hearing chromatic chord function in melodic and harmonic contexts. Sight-singing chromatic melodies and performing chromatic progressions. Aurally recognizing musical form (binary, ternary, strophic). Discovering markedness in common practice era music and recognizing commonalities with and differences from other music cultures A grade of C or better required in prerequisite. 3046: Hearing chord function in advanced chromatic melodic and harmonic contexts. Sight-singing advanced chromatic melodies and performing highly chromatic progressions. Aurally recognizing musical form (sonata, rondo, other forms). Hypothesizing about evolution of style and articulating intertextual experience. A grade of C or better required in prerequisite.
Prerequisite(s): MUS 2046 and MUS 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3046 - Advanced Ear Training (1 credit)
Prerequisite(s): MUS 3045
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3054 - Introduction to Vocal/choral Arranging (3 credits)
Techniques of arranging music for vocal/choral ensembles. Emphasis on transcription from recordings to develop rhythmic, melodic, and harmonic dictation skills. Discussion, transcription, listening, small writing exercises, final project.
Prerequisite(s): MUS 3035 and MUS 3036
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3055 - Music and Media Production (3 credits)
Develops advanced knowledge of music production through practical application of music recording and production technologies, including advanced microphone techniques, critical listening, and critical artistic evaluation skills. Individual and group production projects. Hands-on experience with a variety of expressive media technologies including CD and DVD production in a collaborative, inter- disciplinary team approach.
Prerequisite(s): MUS 2056
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3056 - Music and Media Production (3 credits)
Develops advanced knowledge of music production through practical application of music recording and production technologies, including advanced microphone techniques, critical listening, and critical artistic evaluation skills. Individual and group production projects. Hands-on experience with a variety if expressive media technologies including CD and DVD production in a collaborative, interdisciplinary team approach.
Prerequisite(s): MUS 3055
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3064 - Digital Sound Manipulation (3 credits)
Cross-disciplinary study of recording technology and its effects on music. Aesthetics of electronic music. Recording and editing digital sound. Visual programming for live sound synthesis and processing. Acoustic compilers for programmatic sound processing and synthesis. Individual creative applications of tools learned in class. Team-based work on creative projects. Emphasis on intercultural and global use of creative music technologies.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3065 - Computer Music and Multimedia Design (3 credits)
A two-semester study of interactive multimedia composition and performance software as a foundation for creative work and research endeavors. Also provides an in-depth study of digital sound synthesis, algorithmic creation of multimedia content, and the design of audio-visual interactive systems using latest technologies. Must meet pre-requisite or have permission of the instructor
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3066 - Computer Music and Multimedia Design (3 credits)
A two-semester study of interactive multimedia composition and performance software as a foundation for creative work and research endeavors. Also provides an in-depth study of digital sound synthesis, algorithmic creation of multimedia content, and the design of audio-visual interactive systems using latest technologies. Must meet pre-requisite or have permission of the instructor
Prerequisite(s): MUS 3065
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3074 - Topics in Music Analysis (3 credits)
Contemporary methods of music analysis. Readings from landmark music theory texts and top music theory journals. Analysis of complementary music. Formulating unique research projects to demonstrate mastery of theoretical frameworks. May be repeated 2 times with different content for a maximum of 9 credit hours.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MUS 3114 - Symphonic Literature (3 credits)
Study of representative works of symphonic music from the eighteenth, nineteenth, and twentieth centuries, with corollary readings in the history of musical ideas. Consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3124 - 20th Century Music Literature (3 credits)
An introduction to music in Europe and America since 1945; supplementary study in the aesthetics of contemporary music. Consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3134 - Vocal Music Literature (3 credits)
Covers vocal music of Europe and America, especially music composed the eighteenth century. Examines differences in style and forms of choral and solo-vocal expression characteristic of the Baroque, Classic, Romantic, and Modern eras. Discusses issues of vocal performance practice. Ability to read music required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3144 - Early Music Literature (3 credits)
Covers vocal and instrumental music from the Middle Ages to the eighteenth century. Examines differences in style and forms of expression characteristic especially of Medieval, Renaissance, and early Baroque music. Discusses issues of performance practice. Ability to read music required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3154 - Piano Literature (3 credits)
Study of representative works of keyboard repertoire from the 17th century to the works of contemporary composers. Extensive stylistic analysis and discussion of performance practice. Pre: consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3164 - History of Electronic Music (3 credits)
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3164H - History of Electronic Music (3 credits)
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3174 - Music as Global Culture (3 credits)
Musical traditions from around the globe as both artistic production and cultural practice. Expose students to music from both non-Western and Western traditions. Connect cultural context to musical meaning. Critical engagement with different musics and their histories.
Prerequisite(s): MUS 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3184 - Histories of Music I: Music in the European and American Traditions (3 credits)
Examination of the development of different musical genres in Europe and the Americas from approximately 1600 to 1918. Consideration of historical and sociocultural context. Introduction of a diverse array of styles and genres. Critical engagement with social, cultural, and historical issues and their relation to music. Development of historical research skills, facility with writing about music, and practical applications.
Prerequisite(s): MUS 3174
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3194 - Histories of Music II: Music in the 20th and 21st Centuries (3 credits)
Musical traditions and developments in the twentieth and twenty-first centuries, with emphasis on music (voice, acoustic, and electronic) in the United States and increasing globalization. Introduction of students to music from both non-Western and Western traditions. Critical engagement with formalized and vernacular musics through sociopolitical concepts (race, gender, etc.). Research into music in the twenty-first century United States. Development of both historical and ethnographic research skills. Writing about music.
Prerequisite(s): MUS 3174
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3214 - Teaching Music in the Elementary School (3 credits)
Methods of teaching elementary school music. Emphasis on Kodaly, Orff, and traditional music textbook series approaches to teaching music in elementary schools. Pre: Instructor permission and successful completion of sophomore music continuation exam.
Corequisite(s): MUS 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3225 - Conducting (3 credits)
An introduction to the practice and theory of ensemble conducting and leadership. 3225: Basic conducting skills, and choral conducting. 3226: Intermediate conducting skills, and instrumental conducting. Consent required.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3226 - Conducting (3 credits)
An introduction to the practice and theory of ensemble conducting and leadership. 3225: Basic conducting skills, and choral conducting. 3226: Intermediate conducting skills, and instrumental conducting. Consent required.
Prerequisite(s): MUS 3225
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3234 - Piano Pedagogy (3 credits)
Examination of principles and practice of piano pedagogy. Covers teaching methods, materials and literature for the independent studio teacher. Pre: consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3244 - Vocal Pedagogy (3 credits)
Exploration of historical and modern treatises. Implementation of technical methods to build vocal technique. Experimentation with biofeedback in pedagogical context. Practical application of pedagogical methods. Pre: Successful completion of continuation exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3314 - Instrumental Ensemble Music (1 credit)
Instruction and participation in instrumental music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 8 credit hours

MUS 3414 - Choral Ensemble Music (1 credit)
Instruction and participation in choral music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 8 credit hours

MUS 3814 - Jazz History (3 credits)
A survey and analysis of jazz music, including traditional jazz, big band, bebop, rhythm and blues, free jazz/avant garde, fusion, and hip-hop. Exploration of historical, social, and cultural forces and trends that influence the creation and interpretation of jazz music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3815 - Advanced Jazz Improvisation (2 credits)
Topics will include in-depth analysis of the great improvisers in multiple genres with a focus on developing professional-level skills.
Prerequisite(s): MUS 2816
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

MUS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4014 - Topics in Advanced Electroacoustic Research (3 credits)
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours.
Prerequisite(s): MUS 3066 and MUS 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

MUS 4014H - Topics Adv Electroacoustic Res (3 credits)
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours.
Prerequisite(s): MUS 3066 and MUS 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

MUS 4055 - Music Technology Senior Seminar (1 credit)
Weekly seminars in music technology with group discussion of progress in current student projects, the current state of artistic and business practices in the recording industry, and guest lecturers drawn from the professional world.
Prerequisite(s): MUS 3056
Instructional Contact Hours: (1 Lec, 1 Crd)

MUS 4056 - Music Technology Senior Seminar (1 credit)
Weekly seminars in music technology with group discussion of progress in current student projects, the current state of artistic and business practices in the recording industry, and guest lecturers drawn from the professional world.
Prerequisite(s): MUS 3056
Instructional Contact Hours: (1 Lec, 1 Crd)

MUS 4124 - Special Topics in Music History and Literature (3 credits)
Specific, in depth study of one of several topics in music history and or literature.
Prerequisite(s): MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 4174 - Topics in Musicology (3 credits)
Examine topics in historical musicology and their interdisciplinary resonance. Examination of primary sources, top musicology journals, and monographs as appropriate. Historical and technical analysis of music. Investigation of historical and sociocultural context of music. May be repeated 2 times with different content for a maximum of 9 credit hours.
Prerequisite(s): MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MUS 4204 - Secondary General and Choral Music Education Methods (3 credits)
This course examines philosophical, planning, administrative, organizational, instructional methods, assessment of student learning and cultural performances necessary to manage and teach secondary general and choral music programs.
Prerequisite(s): MUS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 4214 - Instrumental Methods: Elementary (2 credits)
Develop skills and practices to direct an elementary instrumental music program in a school setting. Learn practices, procedures, and strategies for leading rehearsals and lessons, developing curriculum, assessing student learning, and administering a school instrumental program.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4224 - Instrumental Methods: Secondary (2 credits)
Develop skills and practices to direct an instrumental music program in a middle or high school setting. Learn practices, procedures, and strategies for leading rehearsals and lessons, developing curriculum, assessing student learning, and administering a school instrumental music program.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4234 - Topics in Music Education (2 credits)
Study of specialized areas of pedagogy, instruction, administration, and classroom management in music education. Prepares students to lead specialized ensembles and courses in school music contexts. Course can only be taken one time for credit toward degree requirements.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4514 - Advanced Individual Applied Voice (1-3 credits)
Individual instruction in voice at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2514
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4524 - Advanced Individual Applied Keyboard (1-3 credits)
Individual instruction in keyboard at an advanced level. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2524
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4534 - Advanced Individual Applied Violin (1-3 credits)
Individual instruction in violin at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2534
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4544 - Advanced Individual Applied Viola (1-3 credits)
Individual instruction in viola at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2544
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4554 - Advanced Individual Applied Cello (1-3 credits)
Individual instruction in cello at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2554
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4564 - Advanced Individual Applied Bass (1-3 credits)
Individual instruction in bass at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2564
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4574 - Advanced Individual Applied Flute (1-3 credits)
Individual instruction in flute at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2574
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4584 - Advanced Individual Applied Oboe (1-3 credits)
Individual instruction in oboe at an advanced level. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2584
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4594 - Advanced Individual Applied Clarinet (1-3 credits)
Individual instruction in clarinet at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2594
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4614 - Advanced Individual Applied Saxophone (1-3 credits)
Individual instruction in saxophone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2614
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 4624 - Advanced Individual Applied Bassoon (1-3 credits)
Individual instruction in bassoon at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2624
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4634 - Advanced Individual Applied Horn (1-3 credits)
Individual instruction in horn at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2634
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4644 - Advanced Individual Applied Trumpet (1-3 credits)
Individual instruction in trumpet at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2644
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4654 - Advanced Individual Applied Trombone (1-3 credits)
Individual instruction in trombone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2654
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4664 - Advanced Individual Applied Baritone (1-3 credits)
Individual instruction in baritone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2664
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4674 - Advanced Individual Applied Tuba (1-3 credits)
Individual instruction in tuba at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2674
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4684 - Advanced Individual Applied Percussion (1-3 credits)
Individual instruction in percussion at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2684
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4734 - Advanced Individual Applied Composition (1-3 credits)
Individual instruction in composition at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2734
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 4744 - Advanced Individual Applied Conducting (1-3 credits)
Individual instruction in conducting at an advanced level. May be repeated. Consent required.
Prerequisite(s): MUS 2744
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4754 - Advanced Individual Applied Recording (1-3 credits)
Individual instruction through directed experiential learning in music recording and production at an advanced level. Integration of critical listening, acoustics, audio recording, signal processing, audio mixing, and audio mastering with music theory and performance. An emphasis in hands-on exploratory research in the use of instruments, acoustics, microphones, recording, and production techniques combined with traditional methods and emerging technologies to capture and produce recordings in an artistic manner suitable for use in a senior portfolio. Permission required. May be repeated for a maximum of 12 hours.
Prerequisite(s): MUS 2754
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 12 credit hours

MUS 4764 - Advanced Individual Applied Electroacoustics (1 credit)
Individual instruction and completion of a major project in electroacoustic composition, performance, or research, at an advanced level. Repeatable up to three times for a maximum of 3 credit hours.
Prerequisite(s): MUS 3064 and MUS 3066
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

MUS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Nanoscience (NANO)

NANO 1015 - Introduction to Nanoscience (3 credits)
Introduction to the interdisciplinary field of nanoscience with perspectives from biology, geoscience, computational science, chemistry, and physics. 1015: Historical perspectives; public perception; economic impact, nanoscience in biology and environment; quantum physics principles; characterization tools; mathematical modeling. 1016: Nanofabrication methods; nanoparticle synthesis and characterization; self-assembly; applications in medicine, electronics, and energy; sustainability. Pre: 1015 for 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 1016 - Introduction to Nanoscience (3 credits)
Introduction to the intersdisciplinary field of nanoscience with perspectives from biology, geoscience, computational sceince, chemistry, and physics. 1015: Historical perspectives; public perception; economic impact, nanoscience in biology and environment; quantum physics principles; characterization tools; mathematical modeling. 1016: Nanofabrication methods; nanoparticle synthesis and characterization; self-assembly; applications in medicine, electronics, and energy; sustainability. Pre: 1015 for 1016.
Prerequisite(s): NANO 1015
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 2024 - Quantum Physics of Nanostructures (4 credits)
Introduction to the quantum physics which governs the properties of matter at the nanoscale. Specific topics include: Quantization, wave-particle duality, and Schrodinger equation, with applications to the hydrogen atom, periodic crystals, and nanostructures; electron spin, spintronics, and quantum statistical physics.
Prerequisite(s): NANO 1016 and MATH 1226 and (PHYS 2306 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 2114 - Nanoscience Research Seminar (1 credit)
Readings and discussion of current research areas of nanoscience and nanotechnology including nanofabrication, scanning probe techniques, functional nanomaterials, molecular engineering, bionanotechnology and nanomedicine. Presentations by guest nanoscience faculty on their research activities.
Prerequisite(s): NANO 1016
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 2324 - Quantum Physics for Nanomedicine (3 credits)
Introduction to quantum physics with a focus on nanomedicine related topics. Principles of quantization, wave-particle duality, Pauli exclusion principle, and the Schrödinger equation, with applications to the hydrogen atom, regular crystals, and nanostructures. Implications for nanomedicine of quantum dots, surface plasmon resonance, nanoscale sensing, and targeted drug delivery using nanoparticles.
Prerequisite(s): NANO 1016 and (PHYS 2206 or PHYS 2306 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 2814 - NanoCareers (1 credit)
Exploration of career opportunities in nanoscience and nanomedicine, including employment, graduate education, and health professions. Professional development activities, including resume assembly, career fairs, mentorship and networking, elevator pitch, entrepreneurship, and financial literacy. Pre: Sophomore standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 3015 - Nanoscale Synthesis, Fabrication, and Characterization (4 credits)
Tools for synthesis, fabrication and characterization of nanomaterials and nanostructures including organic and polymer synthesis, self-assembly, and top-down fabrication as well as methods for identifying their structure and electronic, optical, and thermal properties. 3015: Multiphase macromolecules; electron and scanning probe microscopies; fullerenes, graphene, and nanotubes; optical and electron spectroscopies, thermal analysis; quantum dots and metallic nanoparticles. 3016: Nucleic acid self-assembly; polyelectrolyte complexes; dynamic light scattering and zeta potential; electrostatic self-assembly; self-assembled monolayers; photolithography; electron and ion beam lithography; microcontact printing and nanoimprint lithography.
Prerequisite(s): CHEM 2514 or CHEM 2535 or CHEM 2565
Corequisite(s): 2024 or 2324 or PHYS 3324.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 3016 - Nanoscale Synthesis, Fabrication, and Characterization (4 credits)
Tools for synthesis, fabrication and characterization of nanomaterials and nanostructures including organic and polymer synthesis, self-assembly, and top-down fabrication as well as methods for identifying their structure and electronic, optical, and thermal properties. 3015: Multiphase macromolecules; electron and scanning probe microscopies; fullerenes, graphene, and nanotubes; optical and electron spectroscopies, thermal analysis; quantum dots and metallic nanoparticles. 3016: Nucleic acid self-assembly; polyelectrolyte complexes; dynamic light scattering and zeta potential; electrostatic self-assembly; self-assembled monolayers; photolithography; electron and ion beam lithography; microcontact printing and nanoimprint lithography.
Prerequisite(s): NANO 3015 and (CHEM 2514 or CHEM 2536 or CHEM 2566)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 3114 - Professional Dissemination of Nanoscience Research (1 credit)
Technical skills for dissemination of nanoscience research. Effective use of the nanoscience and nanotechnology literature, use of technologies that support collaborative oral and written communication. Key elements of effective journal publications and conference presentations.
Prerequisite(s): NANO 2114
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 3124 - Nanoscience and the Environment (3 credits)
Introduction to the connections between nanoscience, nanotechnology, and the environment. Overview of environmental science, why environmental issues are relevant to industry/business/research, naturally-occurring nanomaterials and their roles on Earth, and what is currently known about how manufactured and incidental nanomaterials interact with the atmosphere, hydrosphere, pedosphere, and biosphere.
Prerequisite(s): NANO 1016 and (BIOL 2124 or BIOL 2134 or NEUR 3044) and (CHEM 1036 or CHEM 1056 or ISC 2106H)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4124 - Advanced Nanomaterials and Devices (3 credits)
Overview of types of nanomaterials such as nanoparticles, quantum dots, fullerenes, carbon nanotubes, nanowires, graphene, and ultra-thin films. Special nanocomposite materials. Electronic, optical, magnetic, and transport properties of nanomaterials. Interactions between nanomaterials and substrates or interfaces. Applications of nanomaterials for electronics, magnetic storage, and energy-efficient devices.
Prerequisite(s): NANO 3016 and MATH 2214 and (NANO 2024 or PHYS 3324)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4314 - Nanomedicine (4 credits)
Medical use of nanomaterials including basic, translational, and clinical research. Nanomedical approaches to drug delivery. Diagnostic sensors. Use of nanomedical tools over conventional techniques to treat diseases/disorders. Technical issues associated with medical applications. Bioavailability of nanotherapies. Use of quantum dots for imaging. Ethical concerns and economic benefits associated with nanomedicine.
Prerequisite(s): NANO 3016 and (BIOL 2104 or BIOL 2124)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 4324 - Introduction to Nanomedicine (3 credits)
Overview of fundamental biocompatible technologies under development at the nanoscale level and their application in the biomedical field. Use of various forms and compositions of nanomaterials for potential applications in diagnosis, delivery, imaging, and treatment of human diseases. Focus on synthesis, characterization, and specific applications of nanomaterial as well as on nanotheranostics. Pharmacokinetic distribution of drug-embedded nanocarriers and their pharmacodynamics in biological systems. Nanoscale properties of materials for medical imaging. Classification of nanobiosensors used in clinical settings.
Prerequisite(s): NANO 3015 and (BIOL 2124 or BIOL 2134 or NEUR 3044)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4334 - Advanced Nanomedicine (3 credits)
Medical use of nanomaterials in translational medicine and clinical research. Nanomedical approaches to targeted delivery and local imaging. Diagnostic sensors. Use of nanomedical tools over conventional techniques to diagnose and treat human diseases/disorders. Bioavailability and biocompatibility of nanotherapeutics. Ethical concerns and economic benefits associated with developing and implementing nanomedical approaches in the clinic. Use of nanotechnological advances for surgical procedures. Use of nanoparticles composites for nanodentistry and in nanodermatology. Safety protocols for the use of nanotechnology in clinical treatment.
Prerequisite(s): NANO 4324
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4354 - Advanced Nanomedicine Laboratory (1 credit)
Use of nanotechnology to study cellular and molecular processes relevant to human diseases. Manipulation of nucleic acids. Use of various nanoparticle materials to study nucleic acids uptake by cells. Use of fluorescence and confocal imaging to identify homotypic and heterotypic cellular interactions. Purification of cells from biological fluids. Concepts in dielectrophoresis and microfluidic devices. Students must be certified to work with blood-borne pathogens from the Environmental Health and Safety department.
Prerequisite(s): NANO 4324
Corequisite(s): NANO 4334
Instructional Contact Hours: (3 Lab, 1 Crd)

NANO 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Natural Resources (NR)

NR 1115 - Seeking Sustainability (3 credits)
1115: Strategies to promote sustainability through the identification, description, and analysis of the dominant interconnections within and between environmental, social, and economic systems across local to global scales. 1116: Perceptions of, conditions of, and strategies to analyze processes of change within complex systems, and promote sustainability across local to global scales.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 1115

NR 1116 - Seeking Sustainability (3 credits)
Prerequisite(s): NR 1115 or GEOG 1115
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 1116

NR 1234 - First Year Experience In Natural Resources and Environment (3 credits)
Introduction to problem solving related to natural resources and environmental issues. Developing a sense of identity and place within the college while acquiring skills and knowledge that enhance academic success. Exposure to programs on campus that support sustainability and student success. Introduction to a variety of career pathways within natural resources and environmental conservation.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

NR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 2234 - 1st Semester Experience-Transfer Students in Natural Resources and Environment (2 credits)
Problem solving related to natural resources and environmental issues, focusing on research, writing and oral presentation skills. Orientation to the college while acquiring skills and knowledge that enhance academic success, including university resources and professional/ personal ethics. Introduction to a variety of career pathways within natural resources and environmental conservation. Restricted to transfer students.
Instructional Contact Hours: (2 Lec, 2 Crd)

NR 2554 - Leadership for Global Sustainability (3 credits)
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2554, LAR 2554

NR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

NR 4004 - Professional Skills in Natural Resources (1 credit)
Elements of professionalism and principles of success across a wide spectrum of natural resources careers. Skills for ethical and professional interaction including effective communication, advancement of diversity and inclusion, and personal responsibility. Career preparation principles including employer outreach, job seeking, resume writing, and interview preparation. Guest speakers from academia, industry, and government. Pre: Senior standing.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: FREC 4004

NR 4014 - Natural Resources Economics (3 credits)
Examination of domestic and international natural resource use, exploitation, and degradation problems, with special focus on use of economics to understand why potential overuse of natural resources exists, and what policy options are available to correct these problems and ensure sustainable natural resource use over time. Water, forests, fisheries, land and exhaustible resources. Permission of instructor may be substituted for the pre-requisite.
Prerequisite(s): ECON 2005 or AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4014

NR 4105 - Leadership in Natural Resources (3 credits)
Preparation for leadership roles in the natural resource professions. Introduction to theories of leadership; characteristics of effective leaders; leading and working in interdisciplinary teams. Techniques of meeting facilitation; written and oral communication skills in a leadership context. Effects of preferred modes of interacting with others, perceiving information, making decisions, and approaching tasks on the ability to lead and work with others. Consent of instructor.
Prerequisite(s): FIW 2114 or FOR 2314 or FREC 2314 or GEOG 3104 or SBIO 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

NR 4106 - Leadership in Natural Resources (3 credits)
Preferred styles for dealing with change and conflict; generational change in the workplace; approaches to negotiation and resolution of conflicts. Exploration of specific models of leadership. Application of leadership skills, conflict resolution, teambuilding and project development skills in student group projects. Consent of instructor.
Prerequisite(s): NR 4105
Instructional Contact Hours: (3 Lec, 3 Crd)

NR 4444 - Practicing Sustainability (3 credits)
Practicum in sustainability. Synthesize and integrate knowledge from undergraduate career and apply to real world problems of sustainability. Topics and projects selected from opportunities to examine specific local and regional sustainability issues on the VT campus, in the New River Valley and the Commonwealth at large. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4444

NR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Neuroscience (NEUR)

NEUR 1004 - Neuroscience Orientation Seminar (2 credits)
Introduction to the field of neuroscience. Exposure to areas of practice and research, opportunities for education and training, and employment in the field. Academic and career planning for neuroscience majors. Discussion of university resources to promote student success.
Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2014H - Honors Fundamentals of Neuroscience (3 credits)
Fundamental concepts in neuroscience including nervous system organization, signaling within neurons and across synapses, sensory and motor systems, emotion, memory, and language. Major neurological disorders and animal models used in neuroscience. Restricted to non-neuroscience majors in the Honors College.
Prerequisite(s): BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2025 - Introduction to Neuroscience (3 credits)
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.
Prerequisite(s): BIOL 1005 or BIOL 1105 or ISC 1106H
Corequisite(s): NEUR 2035
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2026 - Introduction to Neuroscience (3 credits)
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.
Prerequisite(s): NEUR 2025
Corequisite(s): NEUR 2036
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2035 - Neuroscience Laboratory (1 credit)
Organization and function of the nervous system. 2035: neuroanatomy, microscopy, intracellular stimulation, extracellular recording, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.
Corequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2036 - Neuroscience Laboratory (1 credit)
Organization and function of the nervous system. 2035: neuranatomy, microscopy, intercellular stimulation, extraceullular recording, nerve stimulation, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.
Prerequisite(s): NEUR 2035
Corequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2364 - Mind Altering Substances from Nature (3 credits)
Neurobiological effects of psychoactive chemicals from nature. Neurotoxic effects and dangers of psychoactive plants and fungi. Therapeutic applications of mind-altering substances in neurological disease. Experimental uses of mind-altering chemicals in neuroscience research. Cultural history, legal standing, regulatory oversight, and contemporary use portrayals of mind-altering substances from nature in medicine and society. Neurobiological effects of psychoactive plant chemicals.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2464 - Neuroscience and Society (3 credits)
Social, ethical, and legal issues faced by human societies from the perspective of neuroscience. Broader questions about how neuroscience informs education, medicine, law, and public health. Research in neuroscience as it relates to issues of mental health, poverty, stress, and politics.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2554 - Experimental Neuroscience (3 credits)
Introduction to the conceptual framework of contemporary experimental methods and practices in neuroscience research. Exploration of experimental techniques including electrophysiology, advanced imaging, immunohistochemistry, transgenic animal models, and behavioral assays. Includes face-to-face interaction with various research faculty to explore research methods in practice and discuss current research and expertise.
Prerequisite(s): NEUR 2025 and NEUR 2035
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2594 - Exploring Clinical Neuroscience (3 credits)
Exploration of careers in clinical neuroscience. Introduction to neuroanatomy, clinical presentation of neurological diseases, application of neuroscientific research to clinical practice, and clinical treatments. Ethical challenges in clinical practice. Burnout and resilience.
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 3034 - Global Perspectives Pre-Departure (2 credits)
Preparation for Global Perspectives in Neuroscience and Medicine summer study abroad program. Travel preparations and financial planning. Academic overview and preparation. Risk management and travel etiquette. Introduction to global perspectives of neurological diseases. Restricted to students accepted into Global Perspectives in Neuroscience and Medicine summer study abroad program.
Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 3044 - Cellular and Molecular Neuroscience (3 credits)
Fundamental principles of cellular and molecular neuroscience. Methods to study neurochemisty and neurobiology, theoretical and practical issues of relating cellular/molecular structures and functions to higher-level nervous system functioning, and current understanding of cellular/molecular bases of nervous system disorders.
Prerequisite(s): NEUR 2025 and (CHEM 1036 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3054 - Brain-Body Interactions in Health and Disease (3 credits)
Role of brain-body interactions in influencing an organism's health. Biological mechanisms involved in bidirectional communication between the brain, endocrine system, immune system, and digestive system. Gut microbiome and gut-brain axis in health and disease. Disease states linked to disturbed communication between brain and body, including diabetes, depression, autism, and Alzheimer's disease.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3074 - Evolutionary Neuroscience (3 credits)
Role of evolution and natural selection in shaping genetic, molecular, and cellular components of brain within invertebrates and vertebrates through modern humans. Evolution of molecules and cells in the brain. Comparing brain structure and function between invertebrates and vertebrates, including evolution of animal and human cognition and behavior. Adaptations of brain structure and function necessary for human cognition, emotion, language, and intelligence.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3084 - Cognitive Neuroscience (3 credits)
Concepts in cognitive neuroscience. Methods available to study brain and nervous system function, theoretical and practical issues of relating mental functions to biological brain functions. Overview of current understanding of the neural bases of various mental functions (e.g., memory, attention, emotion, decision making).
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3144 - Mechanisms of Learning and Memory (3 credits)
Foundation of social interactions in human and non-human: ability to learn and memorize locations, situations, individuals, facts and tasks forms. Cellular and molecular mechanism underlying learning and memory and model systems. Approaches to these processes along with diseases presenting with learning and memory deficits in humans.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3234 - The Artificial Brain (3 credits)
Introduction to brain-machine interactions and computer models of neural systems. Exploration of brain-computer interface applications, biophysically-based computational models of the brain, and computer neural networks in the context of artificial intelligence. Emphasis on the capabilities and limitations of neural networks and how they inform our understanding of the human brain. Discussion of societal impact and ethical considerations.
Prerequisite(s): NEUR 2026 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3554 - Neuroscience Research and Practical Experience (3 credits)
Integration of the interdisciplinary fields of neuroscience: includes the conceptual frameworks and theories of neuroscience spanning molecules to behavior, the methods available to study nervous system structure and function from molecules to behavior, theoretical and practical issues of linking these lower-levels structures and processes to higher-level neurological and psychological functions, and the latest applications and technologies for translating neuroscience into more effective interventions and treatments. Practical experience includes literature review research and writing, data analysis and interpretation, written and oral presentation, and site-specific training.
Prerequisite(s): NEUR 2026 and NEUR 2554
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3594 - Neurobiology of Psychiatric Disorders (3 credits)
Neurobiological and clinical aspects of psychiatry. Overview of disorders such as depression, anxiety, schizophrenia, addiction, and obsessive-compulsive disorder. Neurobiology of emotional behavior. Clinical perspectives of psychiatric treatment, interventional psychiatry, and cross-disciplinary approaches to psychiatry. Underlying pathophysiology of a variety of psychiatric disorders. Neuropharmacology of commonly used psychiatric medications. Ethical issues related to psychiatric care.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3604 - Neurobiochemistry (3 credits)
The biochemical mechanisms of the nervous system, with a focus on the human brain. Bioenergetics and nutrient metabolism in the central nervous system. Synthesis, function, and metabolism of neurotransmitters and neuropeptides, membrane chemistry, structure and function of neurotransmitter receptors and transporters, ion channels and pumps, secretory pathway and intracellular signaling pathways. The biochemistry of neuroactive drugs and toxins.
Prerequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3774 - Neuroendocrinology (3 credits)
Comprehensive survey of the interrelationships between human neural and endocrine systems. Regulatory mechanisms for neural control of hormone secretions, peripheral hormone action on physiological processes, and hormonal influences on behavior.
Prerequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3844 - Computational Neuroscience and Neural Engineering (3 credits)
Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 3844

NEUR 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

NEUR 3914 - Neuroscience of Drug Addiction (3 credits)
History of addiction as a chronic, relapsing brain disease. Neurocircuitry and molecular basis of the brain affected by common drugs of abuse. Overview of the use, abuse, liability, and psychotherapeutic effects of drugs on humans. Common classes of drug abuse: alcohol, sedatives, tobacco/ nicotine, opiods, cannabinoids, psychostimulants, psychedelics, steroids, anti-anxiety, antidepressants, and antipsychotics. Animal models in drug addiction studies. Current and future pharmacotherapeutics for drug addiction treatment and ethical considerations of treatments.
Prerequisite(s): NEUR 2025 and NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3944 - War and the Brain (3 credits)
Neurological and psychological factors associated with military and war. Neuroscientific basis of decision making, mental resilience, and cognitive enhancement. Etiology and treatment of brain injuries sustained during war including post-traumatic stress disorder, traumatic brain injury, and chemical warfare. Neurotechnological advances that shape soldiers and warfare. Ethical considerations of militarization of neuroscience.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4034 - Diseases of the Nervous System (3 credits)
Common brain and Central Nervous System (CNS) disorders ranging from trauma to autism. Genetic, molecules and cellular changes in disease. Therapeutic implications and development of novel drugs. Challenges in drug discovery and implementation of personalized medicine. Ethical issues regarding genetic findings.
Prerequisite(s): NEUR 2026 and NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4044 - Neuroscience Senior Seminar (3 credits)
Integration of methods and results from cutting-edge interdisciplinary neuroscience research; theoretical and practical issues when linking molecular/cellular structures and processes to higher-level neurological and psychological functions. May be repeated twice with different content for a maximum of 9 credits.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

NEUR 4054 - Developmental Neuroscience (3 credits)
Genetic, molecular, and cellular processes underlying brain development and neural circuit formation, including neural induction, cell differentiation, cell fate determination, axon guidance, neuronal migration, synapse formation, and cell death. Neurodevelopment processes in vertebrate and invertebrate animal models. Molecular and cellular underpinnings of neurodevelopmental disorders.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4064 - Neuropharmacology (3 credits)
Role of drugs affecting function of the brain, spinal cord, and peripheral nerves. Principles of pharmacology and biological mechanisms involved in pharmacokinetics (drug absorption, distribution, metabolism, elimination, and toxicity). Neurotransmission in peripheral and central nervous systems. Major classes of drugs affecting the nervous system (antidepressants, anxiolytics, antipsychotics, anticonvulsants, sedatives/hypnotics, analgesics, general and local anesthetics) and their mechanisms of action. Evaluate scientific findings of drug pharmacodynamics for major drug classes used to treat diseases of the nervous system.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4244 - Neural Control of Movement (3 credits)
Neuroscience of motor control and related disorders. How the neural system sub-components involved in motor control mediate motor reflexes, motor learning, central pattern generation, and motor control of speech and language. Sensorimotor physiology, proprioceptive system, exercise physiology. Neuro-rehabilitative technology and disruption of motor control by injury or disease.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4314 - Genetics in Neuroscience (3 credits)
Concepts of classical, modern genetics and epigenetics as it relates to neuroscience. Practical applications including genome-wide association (GWAS), next-generation sequencing, epigenetics, genome editing and screening methods. Use of model organisms in neurogenetic disorders research. Relationship of genetics and its influences on theoretical and practical issues in neurological and neurodevelopmental disorders. Personalized medicine in neurodevelopmental and neurogenetic disorders.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4364 - Neuroscience of Language and Communication Disorders (3 credits)
Concepts of language as distinctive human behavior and central to social life. Neural underpinnings of humans ability to speak and understand language. Neurologic processing of language comprehension and production in healthy and language-impaired individuals. Auditory and visual word recognition, reading, understanding speech, representation of word meaning, language production, and bilingualism. Neuroethology of communication and neurological disorders of communication: dyslexia, stuttering, and aphasia. Theoretical issues in language processing and converging evidence from different techniques and animal models addressing these issues.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4454, PSYC 4454

NEUR 4514 - Neuroimmunology in Health and Disease (3 credits)
Immune system and its role in neurological health and psychiatric and neurological disorders. Details of cell type, functions and signaling of the peripheral and central immune system and sympathetic nervous system. Cross-talk between the brain and immune system across the blood brain barrier and circumventricular organs. Neurobiological basis and treatment options for autoimmune diseases. Role of immune system in psychiatric illness.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4594 - Clinical Neuroscience in Practice (3 credits)
Clinical approaches to diagnose and treat neurological disorders. Diseases include stroke, trauma, brain tumors, psychiatric illnesses, and epilepsy. Clinical experience includes diagnostic procedures, radiological techniques, and surgical procedures in operating room. Patient rounding, follow-up, and outcomes. Medical emergencies and appropriate professional responses. Ethical issues regarding health care, disparity, life and death decisions. Medical profession exploration.
Prerequisite(s): NEUR 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4814 - Nutritional Neuroscience (3 credits)
Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity.
Prerequisite(s): NEUR 2026 or ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4814

NEUR 4914 - Drug Development in Neuroscience (3 credits)
Current approaches and pitfalls for developing therapeutics for treating disorders of the central nervous system (CNS). Theoretical issues and practical applications targeting identification, high-throughput screening, pharmacokinetics and pharmacodynamics, preclinical testing, clinical trials, and the FDA approval process. Ethical implications for drug development and testing.
Prerequisite(s): NEUR 3044 or NEUR 3914
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4964 - Field Work (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4994 - Undergraduate Research (1-19 credits)
$30 fee
Instructional Contact Hours: Variable credit course

NEUR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Nuclear Science & Engineering (NSEG)

NSEG 3145 - Fundamentals of Nuclear Engr (3 credits)
Application of fundamental principles of neutron physics and reactor theory. Introduction to nuclear cross-section data, neutron scattering, nuclear fission, and diffusion theory. Examination of current and next generation nuclear power.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 3146 - Fundamental of Nuclear Engr (3 credits)
Application of fundamental principles of neutron physics and reactor theory. Calculation of critical mass and dimensions of a reactor using modified one-group theory; reactivity changes in the core due to control rods, chemical boron shim, temperature changes, and fissioin production poisons. Determination of reactor thermal design criteria. Introduction to radiation protection and reactor accident analysis. Nuclear enginering ethics principles.
Prerequisite(s): NSEG 3145 or ME 3145
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 3604 - Radiation Detection, Protection and Shielding (3 credits)
Radioactive decay, interaction of charged particles and photons with matter, methods of radiation detection and radiation dosimetry, counting statistics, radiation protection criteria and exposure limits, external radiation protection using time, distance and shielding.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214 or MATH 2214H or MATH 2406H.
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4204 - Nuclear Fuel Cycle (3 credits)
Uranium nuclear fuel cycle: radiation basics, uranium reserves, mining, conversion, enrichment, fuel manufacturing, in-core fuel management and refueling, spent fuel storage, reprocessing/recycling and final disposition as waste in a geologic repository. Introduction to nuclear safeguards and nonproliferation as applied to each step of cycle. Alternative fuel cycles.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Corequisite(s): NSEG 3146
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4214 - Nuclear Power Plant Operations (3 credits)
Emphasis on pressurized water reactor plant operations. Review of boiling water reactor operations. Detailed system functions and operation, reactor plant startup and shutdown procedures, reactor refueling, reactor plant safety analysis, reactor plant licensing, ethics and integrity in the nuclear industry.
Prerequisite(s): NSEG 3145
Corequisite(s): NSEG 3146
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4424 - Reactor Thermal Hydraulics (3 credits)
Fundamental processes of heat generation and transport in nuclear reactors: reactor coolant systems and components, heat generation and spatial distribution, heat transport by conduction and convection, single-phase flow, two-phase flow and boiling, critical heat flux.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Corequisite(s): NSEG 3145
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4994H - Undergraduate Research (1-19 credits)
Honors Section
Instructional Contact Hours: Variable credit course

Peace Studies (PSVP)

PSVP 2044 - Peace and Violence (3 credits)
Introduces major theories of peace and violence. Explores contemporary patterns and root causes of interpersonal, institutional, and structural violence. Particular attention to conflict management, prevention, strategies, and promotion of peace at the local, national, and global levels.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 2444 - Conflict Resolution, Mediation and Peacebuilding (3 credits)
Introduces fundamental principles, values and skills of conflict resolution. Special emphasis on facilitative mediation, restorative justice and other conflict resolution methodologies in the greater context of peacebuilding. Exploration of conflict resolution as tools of personal development and social justice.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4104 - Global Society, Violence and the Prospects for Peace (3 credits)
Examines major theories in the interdisciplinary field of peace studies. Includes current, historical, and global causes, patterns and types of conflict, and methods of conflict resolution. Particular attention given to the philosophical and sociological discussions of the causes of violence and the possibilities for peace.
Prerequisite(s): PSVP 2044 or SOC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 4224 - Victimology (3 credits)
An in-depth exploration of the multifaceted field of victimology. A scientific study of victims and the aftermath of victimization, which delves into the physical, emotional, and psychological consequences victims endure. Provides insights into the historical context of victim studies, various theoretical frameworks, and the evolving role of the criminal justice system concerning victims' rights and advocacy. Additionally, this course examines the societal consequences of victimization and explores preventive, interventionist, and compensatory mechanisms to support victims and mitigate the impact of crimes.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 4224

PSVP 4444 - Schools, Violence, and Justice (3 credits)
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students rights/responsibilities.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4444

PSVP 4484 - Hate Crimes (3 credits)
Focuses on the causes, manifestations, and consequences of hate crimes in the United States. Includes theories of prejudice and biased behavior, the context of perpetration, the individual and community-level effects on the victims, and the political, historical, and social significance of such crimes. Considers broad questions of bias compared to hate, the recognition and prosecution of hate crimes compared to non-bias crimes, the impacts of hate crimes at the individual and community levels, and responses by law enforcement and communities.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 4484

PSVP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Philosophy (PHIL)

PHIL 1204 - Knowledge and Reality (3 credits)
Examines historical and contemporary approaches to such issues as: the nature of reality and the self, the relationship between mind and body, the existence of God, the nature of knowledge and illusion. Application to ethical questions about the fear of death, and the meaning of life.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1304 - Morality and Justice (3 credits)
A critical survey of theories concerning human nature, the meaningful life, and the moral evaluation of actions, persons, and institutions. Theories will be applied to such issues as abortion, justice, and moral problems faced by professionals.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1504 - Critical Thinking (3 credits)
Introduction to critical thinking, the examination of the reasons (grounds, evidence) for claims on any subject matter. Mastery of central concepts of critical thinking: argument, claim, validity and invalidity, strength and weakness, deduction and induction, fallacy, objection and response. Techniques for critical reconstruction and evaluation of arguments, including ethical ones. Formal logic techniques for evaluation of truth-functional and categorical arguments, akin to mechanical computation or derivation. Application of techniques to arguments appearing in ordinary language passages.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1604 - How Science Works (3 credits)
Introduction to scientific methods and reasoning. Foundation for interpreting scientific information and conducting research across a range of fields, especially natural sciences. Topics: use of theories, experiments and models; hypothesis testing and confirmation; deductive, inductive and abductive reasoning; descriptive and inferential statistics; causation; influence of societal values on science; diversity and objectivity in science. Examples from physics, astronomy, geology, environmental science and other fields.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 1984B - Special Study (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

PHIL 2115 - Ancient Through Medieval Philosophy (3 credits)
A critical survey and analysis of the history of Western philosophical thought from its beginnings through the Medieval Period. Addresses and assesses historical theories about issues involving the nature of justice, virtue, ethics, knowledge, and reality. Key concepts analyzed include that of the soul, human flourishing, form and matter, the human function and God. 2115: Presocratics, Socrates, Plato, Aristotle, and the Stoics; 2116: late Greek and Roman philosophy, St. Augustine, St. Thomas Aquinas, and William of Ockham.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2116 - Ancient Through Medieval Philosophy (3 credits)
A critical survey and analysis of the history of Western philosophical thought from its beginnings through the Medieval Period. Addresses and assesses historical theories about issues involving the nature of justice, virtue, ethics, knowledge, and reality. Key concepts analyzed include that of the soul, human flourishing, form and matter, the human function and God. 2115: Presocratics, Socrates, Plato, Aristotle, and the Stoics; 2116: late Greek and Roman philosophy, St. Augustine, St. Thomas Aquinas, and William of Ockham.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2125 - History of Modern Philosophy (3 credits)
Philosophical thought from the seventeenth to the nineteenth century, integrating intercultural analysis and comparisons. 2125: Global traditions in 17th and 18th century natural philosophy, including theories of mind, value, and knowledge. 2126: Global traditions in 18th and 19th century philosophy, including theories of science, knowledge, and value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2126 - History of Modern Philosophy (3 credits)
Philosophical thought from the seventeenth to the nineteenth century, integrating intercultural analysis and comparisons. 2125: Global traditions in 17th and 18th century natural philosophy, including theories of mind, value, and knowledge. 2126: Global traditions in 18th and 19th century philosophy, including theories of science, knowledge, and value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2304 - Global Ethics (3 credits)
Ethical issues in international context. Application of the principles of moral theory to such issues as the obligations of richer nations toward poorer ones, cultural and other forms of relativism, emigration and immigration, nationalism, war, deterrence, intervention, environmental degradation, preservation of natural diversity, and responsibilities toward future generations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2314 - Philosophy of Sex, Gender, and Race (3 credits)
Critical survey of contemporary themes in the philosophy of race and feminist philosophy in the United States. Topics in metaphysics (what is race? what is sex? what is gender?), ethics and political philosophy (oppression, solidarity, and social justice), and epistemology (narrative, standpoint, and white ignorance). Emphasis on situating contemporary philosophical views in social and historical contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2504 - Logic and Language (3 credits)
Introduction to logic, the systematic analysis of expressions and reasoning in natural languages (like English) by means of simplified, formal languages. Foundational to philosophy, linguistics, law and computer science; useful in any discipline in the sciences or humanities where sustained reasoning and argumentation are central. Core semantic concepts: truth and meaning, synonymy, ambiguity, consistency, entailment, truth conditions. Core syntactic concepts: expression, sentence, connective, scope, predicate, term, quantifier. Core deductive reasoning concepts: argument, validity, soundness, proof. Formal languages for propositional logic and predicate logic. Translation between these formal languages and natural language sentences and arguments. Application of formal logic to evaluate natural language argumentation. Moral language and ethical reasoning.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2605 - Reason and Revolution in Science (3 credits)
Study of philosophical approaches to understanding and justifying modes of human reasoning both in science and everyday life. 2605: nature of theory confirmation and falsification; 2606: justifying changing paradigms of human inquiry.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2606 - Reason and Revolution in Science (3 credits)
Study of philosophical approaches to understanding and justifying modes of human reasoning both in science and everyday life. 2605: nature of theory confirmation and falsification; 2606: justifying changing paradigms of human inquiry.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 3015 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3015

PHIL 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3016, PSCI 3016

PHIL 3024 - Topics in Philosophical Movements (3 credits)
Focus on the assumptions, methods and ethical dimensions of one or more contemporary or historically important philosophical movement, such as Pragmatism, Feminism, Existentialism, Islamic Philosophy, Philosophy and African-American Thought, or Philosophy and Literature. May be repeated 2 times with different content for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

PHIL 3314 - Ethical Theory (3 credits)
Careful examination of some important historical or contemporary ethical theories. Includes coverage of such topics as the assessment of character and action, the foundations of ethical theories, their justification, their relationship to scientific theories, and their objective or subjective status. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3314

PHIL 3324 - Biomedical Ethics (3 credits)
Philosophical analysis of ethical issues in medicine and biotechnology, such as problems arising in connection with the relations between physicians and patients, the challenges of cultural diversity, practices surrounding human and animal research, decisions about end of life care, embryonic stem cell research, genetic engineering, biotechnological human enhancement, and social justice in relation to health-care policy.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3334 - Ethical Perspectives on Artificial Intelligence (3 credits)
Critical examination of ethical concepts and theories, such as utilitarianism, deontology and virtue theory, applied to issues that arise in artificial intelligence, including applications in smart design & construction, energy, ubiquitous mobility, and robotics & autonomous systems. Addresses questions such as: How much should privacy be protected in the digital future? How can energy be equitably transported and consumed in relation to poor regions and future generations? Who should autonomous vehicles be programmed to protect or sacrifice in emergency situations? How should we evaluate the effects on family and society of smart technology? Should we fear that robots will take over?
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3414 - Aesthetics (3 credits)
Critical survey and analysis of key concepts in aesthetics and the philosophy of art. Historical and contemporary theories concerning natural beauty, aesthetic experience and properties, the nature and interpretation of artworks, their representational and expressive features, the relationship between artistic value, the value that attaches to nature, and moral value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3454 - Philosophy of Religion (3 credits)
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3454

PHIL 3505 - Modern Logic and Its Development (3 credits)
Logic and logical theory and the history of its development. 3505: Validity of arguments. Syllogistic logic from Aristotle to modern times. Deductive methods in truth functional and quantificational logic through the theory of identity. Translation from English into symbolic form. 3506: Metalogic and the history and philosophy of modern logical theory. Decidability and undecidability, completeness and incompleteness of formal systems. Developments from Cantor to Goedel. Must have 3505 to take 3506.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3614 - Philosophy of the Environment (3 credits)
Philosophical issues in environmental science and policy. Foundational concepts in the environmental sciences, epistemic challenges of environmental research and decision-making, and ethical questions about conservation policy and climate justice. Topics include: the wilderness ideal; biodiversity; effectiveness of different ecosystem restoration techniques; environmental modeling; decision-making under scientific uncertainty; indigenous environmental justice; ethics of de-extinction; values in environmental science; climate change; ethics of geoengineering; and public participation in conservation.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PPE 3884, PSCI 3884

PHIL 4014 - Special Topics in Philosophy (3 credits)
Critical examination of special issues or figures of current philosophical interest at an advanced level. Sample topics: Philosophy and Race; Ludwig Wittgenstein; Origins of Analytic Philosophy; and Animals, Minds and Morality. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

PHIL 4204 - Philosophy of Mind (3 credits)
Current issues in the philosophy of mind such as relation of mind and body, status of the mental, knowledge of ones own and other minds, personal identity, consciousness, mentality of animals and machines, topics in the philosophy of psychology. 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4214 - Metaphysics (3 credits)
Critical survey and analysis of key concepts in metaphysics, the study of what kinds of entities exist and what their most fundamental and general features are like. Historical and contemporary theories concerning existence, abstract entities, material objects, time, persistence, possibility and necessity, causation, free will and determinism, and social ontology. Pre: Requires the completion of 3 credits Philosophy course.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4224 - Epistemology (3 credits)
Theory of knowledge. Is all knowledge based on experience? Does knowledge have a foundation? Can knowledge of the present and the nearby give us reasons for beliefs about the future, the past, or about events far away? 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4304 - Political Philosophy (3 credits)
Study of fundamental topics in political philosophy, such as distributive justice, equality, individual rights, constitutional government, and the justification of political authority. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 4304

PHIL 4324 - Business and Professional Ethics (3 credits)
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 4324

PHIL 4334 - Jurisprudence (3 credits)
An examination of the nature of law and legal systems with attention to traditional theories of law and to such topics as judicial decision and discretion, law and morality, the justification of legal coercion. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4514 - Special Topics in Logic (3 credits)
Topics that build upon a knowledge of classical deductive logic: extensions of classical logic, alternatives to classical logic, philosophy of logic, and philosophy of language. Topics to be announced each semester course is offered.
Prerequisite(s): PHIL 3505
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4604 - Philosophy of Biology (3 credits)
This course is designed primarily for students of biology or philosophy students with a strong interest in biology. Topics vary from year to year, but include the changing character of biology as a science, the special character of biological explanations and methods, and the place and value of reduction (e.g., of Mendelian to molecular genetics) in biology.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4614 - Philosophy of Science (3 credits)
An examination of the structure and methodology of science as well as key concepts such as explanation, confirmation, realism, and instrumentalism. One year of science and 3 philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Philosophy, Politics, and Econ (PPE)

PPE 1004 - Introduction to Philosophy, Politics, and Economics (3 credits)
Discussion of classic and contemporary texts in philosophy, politics, and economics (PPE) with historical and current relevance. Core concepts, ideas, and topics include: history of moral, political, and economic thought; political economy; justice, equality, fairness, and democracy; socioeconomic status, power, class, and diversity; the human condition and its cultural evolution and experience in the United States and abroad. Course introduces students to basic principles of research and writing. First-Year Experience course.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 1214 - Economic History of Diversity and Inclusion (3 credits)
Economic analysis of topics concerning diversity and inclusion. Emphasis on Virginia and surrounding states. Introduction to the basic principles of economic analysis and economic history, with a special emphasis on models of institutional change, economic growth, discrimination, inequality, migration, and indigenous economic systems. Impact of institutions, environment, and technological change on labor markets, asset markets, and standard of living. Consideration of the role of data in understanding diversity and related ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 1214

PPE 2024 - Research Methods in Political Science (3 credits)
Introduction to research in political science; formulation of theory, operationalization and measurement, gathering, analysis and interpretation of data.
Prerequisite(s): (PSCI 1014 or PSCI 1014H) and (PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2024

PPE 2894 - PPE Gateway Course (3 credits)
Integrated study of philosophy, politics, and economics. Trains students to make decisions that are not only economically sound, but also socially, ethically, and politically informed. Core concepts, topics, and ideas include: models of human nature, rational choice theory, social cooperation, distributive justice, markets, and democracy. Pre: Sophomore standing.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3016, PSCI 3016

PPE 3024 - Economic Justice (3 credits)
This course explores how different assumptions regarding the basis of claims for access to economic resources lead to different outcomes. Students will explore a variety of theories and examine their own beliefs about economic justice.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3024

PPE 3314 - Ethical Theory (3 credits)
Careful examination of some important historical or contemporary ethical theories. Includes coverage of such topics as the assessment of character and action, the foundations of ethical theories, their justification, their relationship to scientific theories, and their objective or subjective status. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3314

PPE 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PHIL 3884, PSCI 3884

PPE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

PPE 4304 - Political Philosophy (3 credits)
Study of fundamental topics in political philosophy, such as distributive justice, equality, individual rights, constitutional government, and the justification of political authority. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 4304

PPE 4884 - PPE Capstone Course (3 credits)
Discussion of advanced concepts, methods, and ideas at the intersection of philosophy, politics, and economics. Focus on utility theory, game theory, social choice theory, public choice theory, markets, justice, and democracy. Senior research project. Senior standing required.
Prerequisite(s): PPE 2894 or PHIL 2894 or PSCI 2894 or ECON 2894
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Physics (PHYS)

PHYS 1055 - Introduction to Astronomy (3 credits)
Survey course of astronomy topics ranging from the solar system to the universe, with Application of evidence-based reasoning, critical thinking, and use of theoretical models and observations. 1055 has a focus on the solar system: apparent sky motions, telescopes, matter and radiation, properties of the planets, structure and evolution of the solar system, cultural and intercultural aspects that influenced the understanding of the solar system, climate change as a Global challenge. 1056 has a focus on the universe: stars, star formation, stellar evolution, organization of the Milky Way Galaxy, galaxies, quasars, structure and evolution of the universe, cosmological models, cultural and intercultural aspects of the development of astronomical thought, life in the universe.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 1056 - Introduction to Astronomy (3 credits)
Survey course of astronomy topics ranging from the solar system to the universe, with Application of evidence-based reasoning, critical thinking, and use of theoretical models and observations. 1055 has a focus on the solar system: apparent sky motions, telescopes, matter and radiation, properties of the planets, structure and evolution of the solar system, cultural and intercultural aspects that influenced the understanding of the solar system, climate change as a Global challenge. 1056 has a focus on the universe: stars, star formation, stellar evolution, organization of the Milky Way Galaxy, galaxies, quasars, structure and evolution of the universe, cosmological models, cultural and intercultural aspects of the development of astronomical thought, life in the universe.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 1155 - Astronomy Laboratory (1 credit)
Simulation of apparent sky motions; observations of planets, stars, and nebulae with quantitative analysis; long term observations of sky changes; analysis of images; laboratory experiments of astrophysical relevance.
Corequisite(s): PHYS 1055
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 1156 - Astronomy Laboratory (1 credit)
Simulation of apparent sky motions; observations of planets, stars, and nebulae with quantitative analysis; long term observations of sky changes; analysis of images; laboratory experiments of astrophysical relevance.
Prerequisite(s): PHYS 1155
Corequisite(s): PHYS 1056
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2074 - Highlights of Contemporary Physics (3 credits)
Conceptual overview of modern scientific thinking in physics, with application of critical reasoning and quantitative and conceptual problem solving based on fundamental physics principles. Presentation of the key ideas and philosophical aspects of the most important developments in modern physics, such as quantum mechanics, relativity, particle physics, cosmology. Discussion of their impact on our understanding of the universe, our position in it, intercultural aspects, and the relevance of physics for technical challenges requiring global awareness.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2205 - General Physics (3 credits)
General physics course sequence for students in curricula other than physical sciences, mathematics, or engineering, who have not studied calculus. Applications of reasoning in the natural sciences using physical laws in a real-world context and in the students own discipline. Overview of intercultural and universal aspects of physics, and of human benefits of physics to address global challenges. 2205: mechanics, wave phenomena, fluids. 2206: optics, thermodynamics, electromagnetism, relativity, topics in nuclear and modern physics.
Prerequisite(s): MATH 1025 or MATH 1026 or MATH 1225 or MATH 1524
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2206 - General Physics (3 credits)
General physics course sequence for students in curricula other than physical sciences, mathematics, or engineering, who have not studied calculus. Applications of reasoning in the natural sciences using physical laws in a real-world context and in the students own discipline. Overview of intercultural and universal aspects of physics, and of human benefits of physics to address global challenges. 2205: mechanics, wave phenomena, fluids. 2206: optics, thermodynamics, electromagnetism, relativity, topics in nuclear and modern physics.
Prerequisite(s): (PHYS 2305 or PHYS 2205) and (MATH 1025 or MATH 1026 or MATH 1225 or MATH 1524)
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2215 - General Physics Laboratory (1 credit)
Laboratory experiments dealing with basic laws and techniques of physics; designed to illustrate topics covered in PHYS 2205-2206. Applications of reasoning in the natural sciences using physics experiments in a real-world and interdisciplinary context. Ethical responsibilities and issues in a laboratory setting. 2215: analysis of experimental errors, formatting for presenting graphical data, analyzing and describing and prioritizing experimental design features, communicating concepts orally and in writing, concepts of force, momentum, conservation of energy, wave and interference phenomena. 2216: analysis of experimental errors, communicating concepts orally and in writing, concepts of geometrical optics, optical instruments, heat and phase transitions, electricity and electrical energy storage, magnetic fields and magnetic induction, atomic spectra.
Corequisite(s): PHYS 2205
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2216 - General Physics Laboratory (1 credit)
Laboratory experiments dealing with basic laws and techniques of physics; designed to illustrate topics covered in PHYS 2205-2206. Applications of reasoning in the natural sciences using physics experiments in a real-world and interdisciplinary context. Ethical responsibilities and issues in a laboratory setting. 2215: analysis of experimental errors, formatting for presenting graphical data, analyzing and describing and prioritizing experimental design features, communicating concepts orally and in writing, concepts of force, momentum, conservation of energy, wave and interference phenomena. 2216: analysis of experimental errors, communicating concepts orally and in writing, concepts of geometrical optics, optical instruments, heat and phase transitions, electricity and electrical energy storage, magnetic fields and magnetic induction, atomic spectra.
Prerequisite(s): PHYS 2215 or PHYS 2305
Corequisite(s): PHYS 2206
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2254 - Hello Quantum World! (3 credits)
Introduction to the concepts of quantum mechanics and quantum computing using a pictorial approach. Quantum bits, quantum superposition, quantum gate operations, quantum entanglement, and quantum measurements represented pictorially. Demonstration of quantum circuits and quantum algorithms. Use of cloud quantum processors with drag-and-drop interfaces. Quantum teleportation, no-cloning theorem, quantum key distribution. Use of the pictorial formalism to define the concept of vectors.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2305 - Foundations of Physics (4 credits)
Introductory sequence for students in physical sciences, mathematics, and engineering. Overview of intercultural contributions to physics and universal aspects of physics, and of human benefits of physics to address world-wide challenges. 2305: classical mechanics of translational and rotational motion, Newtonian gravitation, and thermal physics. 2306: oscillations, waves, electricity, magnetism, and optics.
Prerequisite(s): MATH 1225
Corequisite(s): MATH 1226
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 2306 - Foundations of Physics (4 credits)
Introductory sequence for students in physical sciences, mathematics, and engineering. Overview of intercultural contributions to physics and universal aspects of physics, and of human benefits of physics to address world-wide challenges. 2305: classical mechanics of translational and rotational motion, Newtonian gravitation, and thermal physics. 2306: oscillations, waves, electricity, magnetism, and optics.
Prerequisite(s): MATH 1226 and PHYS 2305
Corequisite(s): 2325 or (MATH 1206 or MATH 1206H or MATH 1226) for 2305.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 2324 - Thermal Physics Module (1 credit)
Introduction to thermal physics; solids, liquids, and gases; moles, temperature, ideal gas law; work, heat, first law of thermodynamics, ideal gas processes; molecular speeds, pressure; heat engines, refrigerators, the second law of thermodynamics. Intended for transfer students whose introductory physics courses did not include thermal physics. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2325 - Seminar for Physics Majors (1 credit)
Introduction to the field of physics and to the Physics Department. Overview of modern physics topics such as special relativity, quantum mechanics, condensed matter, nuclear, and particle physics. Presentation of research activities in the department. Also provides more in-depth discussion of and math preparation for topics in 2305-2306. For physics majors.
Corequisite(s): PHYS 2305
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2326 - Seminar for Physics Majors (1 credit)
Introduction to the field of physics and the Physics Department. Overview of modern physics topics such as special relativity, quantum mechanics, condensed matter, nuclear, and particle physics. Presentation of research activities in the department. Also provides more in-depth discussion of and math preparation for topics in 2305-2306. For physics majors.
Prerequisite(s): PHYS 2325
Corequisite(s): PHYS 2306
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2334 - Waves and Sound Module (1 credit)
Introduction to mechanical waves and sound; one-dimensional waves, transverse waves, sinusoidal waves; sound waves; waves in two- and three-dimensions; power, intensity; the Doppler Effect; principle of superposition of waves; standing waves, standing waves on a string, standing sound waves; interference of waves, interference in two and three-dimensions. Intended for transfer students whose introductory physics courses did not include the topics of mechanical waves and sound. Pass/Fail only.
Prerequisite(s): PHYS 2305
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2344 - Optics Module (1 credit)
Introduction to ray and wave optics; the ray model for light; reflection and refraction; image formation by mirrors; image formation by lenses; lenses in combinations, optical instruments; the wave model of light; interference of light waves; diffraction of light waves. Intended for transfer students whose introductory physics courses did not include introductory optics. Pass/Fail only.
Corequisite(s): PHYS 2334
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2404 - Physics Outreach (2-19 credits)
Service learning through teaching. An early field experience for physics students who are interested in physics education. Visit local schools and host campus visits to teach K-12 students fundamental physics concepts by performing physics demonstrations and activities. Learn successful communication techniques, lead classroom discussions, and utilize pedagogical content knowledge to effectively organize physics presentations to the general public. Repeatable (no maximum).
Corequisite(s): PHYS 2305
Instructional Contact Hours: (2-19 Lec, 2-19 Crd)

PHYS 2504 - Math Methods in Physics (3 credits)
Applications of mathematical methods to physics. Topics include spatial coordinate systems, linear algebra techniques in coupled motions, series approximations of solutions to physical systems, extremum problems in physics, differential equations in mechanics, integration in two and three spatial dimensions, probability theory in thermal physics.
Prerequisite(s): PHYS 2305
Corequisite(s): 2306, (MATH 2214 or 2214H) and (MATH 2224 or 2204 or 2204H).
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2964 - Field Study (1-9 credits)
Instructional Contact Hours: (1-19 Lec, 1-9 Crd)

PHYS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PHYS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

PHYS 3154 - Observational Astrophysics (2 credits)
Telescopic observations of the moon, planets, stars, interstellar medium, and galaxies; astrophotography; digital imaging. Telescopes; virtual observing techniques and instruments; photographic and digital imaging systems. Astronomical data reduction and interpretation; digital image processing. Prior credit for PHYS 2154 precludes credit for 3154.
Prerequisite(s): PHYS 1156
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

PHYS 3254 - Enriched Physics Outreach (3 credits)
Design and implementation of physics lesson plans for K-12 students at local schools and campus visits. Creation of inquiry-based, student-centered physics lessons which motivate and educate students of all ages. Development of activities and experiments to engage students in being scientists.
Corequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3314 - Intermediate Laboratory (3 credits)
Characteristics of common instrumentation and basic circuits, methods of producing good practices in data gathering, recording, and analysis.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PHYS 3324 - Modern Physics (4 credits)
Photons and their interactions with matter, wave-particle duality, Heisenberg uncertainty principle, Schrodingers equation of motion, hydrogenic and multi-electron atoms, Pauli exclusion principle, molecules, solids, nuclei, elementary particles. Includes lab work. MATH 4544 can be substituted for co-requisite MATH 2214 or 2214H. Pre: 2306.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214 or MATH 2214H.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 3355 - Intermediate Mechanics (3 credits)
Formal aspects of classical mechanics and dynamics. Topics include Newtonian, Lagrangian and Hamiltonian theory applied to non-relativistic systems in one, two, and three dimensions, relativistic dynamics, linear algebra applied to coupled many-body motion, small oscillations, and rigid body motion.
Prerequisite(s): (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204 and MATH 2214) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204 and MATH 2214H) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204H and MATH 2214) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204H and MATH 2214H) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3356 - Intermediate Mechanics (3 credits)
Formal aspects of classical mechanics and dynamics. Topics include Newtonian, Lagrangian and Hamiltonian theory applied to non-relativistic systems in one, two, and three dimensions, relativistic dynamics, linear algrbra applied to coupled many-body motion, small oscillations, and rigid body motion.
Prerequisite(s): PHYS 3355
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3405 - Intermediate Electricity and Magnetism (3 credits)
Electrostatics, multipoles, Laplaces equation, and dielectric media. Magnetostatics, magnetic media, and electromagnetic induction. Maxwells equations, electromagnetic energy, waves, and radiation. Must meet pre-requisites and have a grade of C or better in each of 2305-2306 sequence.
Prerequisite(s): (MATH 2214 or MATH 2214H) and PHYS 2305 and PHYS 2306 and PHYS 2504
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3406 - Intermediate Electricity and Magnetism (3 credits)
Electrostatics, multipoles, Laplaces equation, and dielectric media. Magnetostatics, magnetic media, and electromagnetic induction. Maxwells equations, electromagnetic energy, waves, and radiation. Must meet pre-requisites and have a grade of C or better in each of 2305-2306 sequence.
Prerequisite(s): PHYS 3405
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3655 - Introduction to Astrophysics (3 credits)
Application of elementary physical laws to determine dimensions, masses, luminosities, structures, and evolution of astronomical objects and the universe as a whole. Emphasis is on quantitative derivation.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3656 - Introduction to Astrophysics (3 credits)
Application of elementary physical laws to determine dimensions, masses, luminosities, structures, and evolution of astronomical objects and the universe as a whole. Emphasis is on quantitative derivation.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3684 - Quantum Software I (2 credits)
Organization of quantum information (assemblies of bits) for quantum-computing applications in chemistry, physics, biology, and computer science. Numerical methods for quantum software, emphasizing spin lattices and simulations such as quantum games. Best practices for programming, including techniques for quantum-coding (in Python or Julia), structuring a software product for quantum-computational science use, version control, and cloud-based documentation and code-sharing (via Github). Classical/quantum translation.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 3144
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: CHEM 3684

PHYS 3704 - Thermal Physics (3 credits)
Introduction to the concepts, formalism, and applications of classical and quantum statistical mechanics, including thermodynamics.
Prerequisite(s): PHYS 2306 and PHYS 3324
Corequisite(s): 2504, (MATH 2214 or 2214H).
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4224 - Physics Teaching and Learning (2 credits)
Seminar course on how people learn and understand key concepts in physics to encourage more effective teaching strategies. Discussions of readings in physics, physics education research, and cognitive science. Recognition of common student preconceptions of physics concepts and identification of strategies which help to elicit conceptual change. Field work teaching precollege or college students. For students interested in teaching and learning physics, graduate teaching assistants, and undergraduate learning assistants.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (2 Lec, 2 Crd)

PHYS 4254 - Quantum Information Technologies (3 credits)
Quantum computing and other quantum information technologies. Differences between bit and qubit. Quantum logic gates, concept of entanglement, quantum teleportation, quantum cryptography and key distribution, quantum computing algorithms, including Deutsch-Jozsa algorithm, Grovers search algorithm, Shors factoring algorithm. Basics of public-key cryptosystems and number theory as needed to present Shors algorithm. Errors in a quantum computer and quantum error correction.
Prerequisite(s): MATH 2114 or MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4264 - Quantum Optics and Qubit Processors (3 credits)
Quantum optics and quantum bit (qubit) platforms for quantum technology applications. Qubit as physical system, quantum unitary evolution as quantum gate, quantum control using electromagnetic fields, Rabi oscillations, adiabatic theorem, density matrix, Liouville-von Neumann equation, decay and decoherence (T1 and T2), spin echo, Ramsey interferometry, coherent population trapping, entanglement, dynamical maps, electromagnetic field quantization, Jaynes-Cummings Hamiltonian, spontaneous emission, solid-state qubit platforms (spin qubits, superconducting qubits), atomic qubit platforms (trapped ions), color-centers in solids.
Prerequisite(s): PHYS 4455
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4315 - Modern Experimental Physics (2 credits)
Representative apparatus, techniques, and phenomena of contemporary research. Includes electrical measurements, computers, thermometry, vacuum deposition, machine shop, nuclear spectra, experimentation related to major developments of modern physics.
Prerequisite(s): PHYS 3314
Instructional Contact Hours: (6 Lab, 2 Crd)

PHYS 4316 - Modern Experimental Physics (2 credits)
Representative apparatus, techniques, and phenomena of contemporary research. Includes electrical measurements, computers, thermometry, vacuum deposition, machine shop, nuclear spectra, experimentation related to major developments of modern physics.
Prerequisite(s): PHYS 3314 and PHYS 4315
Instructional Contact Hours: (6 Lab, 2 Crd)

PHYS 4455 - Introduction to Quantum Mechanics (3 credits)
Experimental bases; postulates; conservation theorems and symmetry; one-dimensional and two-dimensional problems; angular momentum and problems in three dimensions; matrix mechanics and spin; applications to atomic and molecular physics; perturbation theory; scattering.
Prerequisite(s): PHYS 3355
Corequisite(s): PHYS 3406
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4456 - Introduction to Quantum Mechanics (3 credits)
Experimental bases; postulates; conservation theorems and symmetry; one-dimensional and two-dimensional problems; angular momentum and problems in three dimensions; matrix mechanics and spin; applications to atomic and molecular physics; perturbation theory; scattering.
Prerequisite(s): PHYS 4455
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4504 - Introduction to Nuclear and Particle Physics (3 credits)
Structure and properties of atomic nuclei and elementary particles, theoretical interpretations based on elementary quantum mechanics. Symmetries; various nuclear models; interactions at small distances; classification of elementary particles. Consent required.
Corequisite(s): PHYS 4456
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4514 - Introduction to Nuclear Physics (3 credits)
Nuclear properties and nuclear interactions. Nuclear reactions and radioactive decays, including alpha, beta and gamma decays. Theoretical models of the nucleus and their interpretations. Experimental methods in nuclear physics. Applications, including nuclear power production.
Prerequisite(s): PHYS 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4524 - Intro Particle Physics (3 credits)
Relativistic kinematics. Particle interaction amplitudes and cross sections. Particle types including quarks, hadrons, leptons and bosons. Experimental methods in particle physics. Symmetries. The quark model. Weak interactions and electroweak unification. Particle physics beyond the Standard Model.
Prerequisite(s): PHYS 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4534 - Quantitative Analysis of Physics Experiments (3 credits)
Statistical analysis of physics experiments. Probabilistic elements in experiments. Data analysis frameworks in physics subfields. Maximum likelihood estimation and Bayesian techniques. Physical principles and nuisance parameters. Analysis strategies and computational methods. Graphical data representation.
Prerequisite(s): PHYS 2504 and PHYS 3324 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4554 - Introduction to Solid State Physics (3 credits)
Basic concepts of solid state physics including crystal structure, lattice vibrations, electron states, energy bands, semiconductors, metals. Consent required.
Corequisite(s): PHYS 4456
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4564 - Polymer Physics (3 credits)
Introduction to the field of polymer physics. Statistical descriptions of polymers based on Brownian motion and random walk models. Conformations and single chains. Thermodynamics of polymer mixtures, solutions, and melts. Properties of polymer networks. Polymer dynamics in both melt and solution states.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4574 - Nanotechnology (3 credits)
Introduction to methods of controlling matter on the nanometer length scale and the applications thereof. Nanolithography, self-assembly, and scanned probe microscopy; nanomaterials including fullerenes, carbon nanotubes, and quantum dots; nanoscale and molecular electronics; nanoelectromechanical systems; nanoscale optoelectronics; and nanobiotechnology.
Prerequisite(s): PHYS 2205 and PHYS 2206 or PHYS 2305 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4614 - Optics (3 credits)
Fundamentals of the ray, wave and quantum models of light, and topics in modern optics with contemporary applications.
Prerequisite(s): PHYS 2306 and (MATH 2214 or MATH 2214H) and (MATH 2224 or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4624 - Optics Laboratory (1 credit)
Laboratory experiments dealing with ray and wave optical phenomena designed to illustrate and complement the principles covered in OPTICS PHYS 4614. Physics majors are required to take 4624 concurrently with the lecture course 4614.
Corequisite(s): PHYS 4614
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 4634 - Modern Classical Physics (3 credits)
Geometric formulation of classical physics. Applications in relativity, optics, elasticity, fluid mechanics, plasma physics. Real-world examples from fundamental, experimental, and applied physics. Quantum roots of and quantum techniques in classical physics. Geometrical connections between classical mechanics, optics, and quantum physics. Problems in and connections between elasticity, fluid dynamics, magnetohydrodynamics, and plasma physics.
Prerequisite(s): PHYS 3355 and PHYS 3405
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4654 - Modern Cosmology (3 credits)
Survey of our current understanding of the origin, evolution, and fate of the Universe. Observational evidence behind the idea of the hot Big Bang, including the linear velocity-distance law, the existence of the cosmic microwave background, and the arguments for dark matter. Physics of a dynamic, expanding Universe via the Friedman-Lemaitre- Robertson-Walker metric. Physical principles to determine the conditions in the early Universe, introducing the idea of inflation. Mechanisms driving the origin and evolution of galaxies and large-scale structures.
Prerequisite(s): PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4664 - Astroparticle Physics (3 credits)
Observations of high-energy photons, cosmic rays, and neutrinos. Energy-loss interactions in astrophysical environments. Propagation of cosmic particles and ultra-high energy cosmic rays. Origins of cosmic rays. Astrophysical neutrinos and neutrino oscillations. Stellar evolution and evolution into supernova explosions. Mechanisms of astrophysical particle acceleration. Multi-messenger astronomy.
Prerequisite(s): PHYS 3655 or PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4674 - Introduction to General Relativity (3 credits)
Introduction to methods and applications of Einsteins general theory of relativity. Space and time and gravity in Newtonian physics; special theory of relativity, gravity as geometry of curved space-time; black holes; cosmology; Einsteins gravitational field equations; gravitational waves and relativistic stars.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2514) and PHYS 3355
Corequisite(s): PHYS 3406
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4684 - Quantum Software II (1 credit)
Modern software collaboration techniques and tools including collaborative code repositories and cloud-based documentation. Application of structure and version control to software and documentation. Developing code with industry-standard quantum-software modules. Hands-on scientific coding for quantum problems. Project management skills including proposal development and technical presentation delivery.
Prerequisite(s): CHEM 3684 or PHYS 3684
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: CHEM 4684

PHYS 4714 - Introduction to Biophysics (3 credits)
Selected topics from the general area of biomechanics, bioelectricity, radiation biophysics, molecular biophysics, and thermodynamics and transport in biological systems. Emphasis on the physical aspects of biological phenomena and biophysical measurement techniques and instrumentation.
Prerequisite(s): PHYS 2206 or PHYS 2306 or ISC 2106H
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4724 - Soft Matter Physics (3 credits)
Physical characteristics of various soft matter systems including liquids, liquid crystals, polymers, colloids, surfactants, granular materials, and biological soft materials. Van der Waals and electrostatic interactions in the context of soft matter. Descriptions of soft matter phases, phase diagrams, phase separation, and phase transitions. Theories of self-assembly and self-organization. Problems in and connections between elasticity, viscoelasticity, and mechanics of fluids including capillarity and wetting. Model of random walk and its applications to colloidal systems. Applications of variational methods in soft matter. Computer simulation methods in soft matter.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4755 - Introduction to Computational Physics (3 credits)
Survey of computational methods in physics. 4755: Applications in physics of curve fitting, numerical calculus, ordinary and partial differential equations, numerical methods for matrices, spectral analysis, and N-body systems. 4756: Investigation of physical systems using Molecular Dynamics simulations, Monte Carlo simulations, genetic algorithm and numerical renormalization. Introduction to advanced techniques, as for example density matrix renormalization group method, matrix product state approach, smoothed particle hydrodynamics, and density functional theory.
Prerequisite(s): PHYS 2306 and CS 1044 or CS 1054 or CS 1064 or CS 1114 or ECE 1574 or AOE 2074 or ESM 2074
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4756 - Introduction to Computational Physics (3 credits)
Survey of computational methods in physics. 4755: Applications in physics of curve fitting, numerical calculus, ordinary and partial differential equations, numerical methods for matrices, spectral analysis, and N-boyd systems. 4756: Investigation of physical systems using Molecular Dynamics simulations, Monte Carlo simulations, genetic algorithm and numerical renormalization. Introduction to advanced techniques, as for example density matrix renormalization group method, matrix product state approach, smoothed particle hydrodynamics, and density functional theory.
Prerequisite(s): PHYS 4455 and PHYS 4755
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4774 - Intro to Physics of Galaxies (3 credits)
Survey of our current observational and theoretical understanding of the formation and evolution of galaxies. Observational review of galaxy sizes and compositions, including the origin of the Hubble sequence. Physical description of a galaxy via distribution functions and stellar orbits. Time evolution of the distribution function. The Schwarzschild method for determining orbits. The physics of active galaxies.
Prerequisite(s): PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PHYS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Plant Pathology, Physiology, and Weed Science (PPWS)

PPWS 2004 - Mysterious Mushrooms, Malicious Molds (3 credits)
Study of the fungi and their close relatives, with special attention to their roles in the natural world and in shaping the course of human history. Historical and practical significance of fungi as sources of medicine, pathogens of plants and animals, rotters and decayers of organic matter, makers of food and drink, manufacturers of dangerous toxins, and producers of mind-altering chemicals. A student must have a basic understanding of biology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2104 - Plants, Genes, and People (3 credits)
Explores how and why humans have manipulated plant genomes from prehistory through the current genomic era by examining the scientific, cultural, historical, and legal aspects of plant gene management in both conventional and transgenic crops.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2754 - Weeds That Shape Our World (3 credits)
How weeds shape our world, and why society will never get rid of them. Introduction to weed identification, weeds in their socio-cultural, environmental, and economic context. Consideration of the tension among their beneficial aspects, control, human attitudes, and the ethical dilemmas they post to society.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4104 - Plant Pathology (4 credits)
Introduction to plant pathology as a science and a crop protection discipline. Plant disease diagnosis, biology, and identification of plant disease-causing agents, factors leading to disease build-up, and management of plant diseases. Diseases of specific crops are studied as examples to illustrate general principles.
Prerequisite(s): (BIOL 1005 or BIOL 1105) and (BIOL 1006 or BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PPWS 4114 - Microbial Forensics and Biosecurity (3 credits)
Concepts of comparative and evolutionary genomics for pathogen characterization and identification taught through case studies of bioterrorism, involuntary and voluntary disease transmission, infectious disease epidemics, and genetically modified organisms; emphasis placed on unambiguous source attribution of a disease outbreak to a particular microbe, risk assessment, response as individual, community, and nation to a bioterrorism attack or disease outbreak, federal biosecurity regulations, and career opportunities.
Prerequisite(s): BIOL 2604 or PPWS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 4154 - Plant Problem Diagnosis (3 credits)
Plant problem diagnosis in the laboratory and field, including recognition of disease, insect and abiotic (nonliving) problems, as well as the major groups of plant pathogens of a variety of regionally important horticultural and agronomic crops. General management options for pests and pathogens.
Corequisite(s): PPWS 4104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4264 - Pesticide Usage (3 credits)
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENT 4264

PPWS 4504 - Fundamentals of Plant Physiology (3 credits)
Fundamental principles of plant physiology (photosynthesis, respiration, transpiration, nutrition, translocation, and development) will be integrated with discussion of the relationship between abiotic environmental factors and plant physiological processes. Both agricultural and non-crop plants will be emphasized.
Prerequisite(s): (BIOL 1006 or BIOL 2304) and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 4604 - Biological Invasions (3 credits)
Broad overview of the causes, consequences, and epidemiology of invasive plants, animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day, covering the invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment will be covered via case studies, within a policy context.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4754 - Weed Science: Principles and Practices (3 credits)
Weeds and human affairs; costs and losses; emphasis on weed biology, weed identification and weed-crop ecology; agronomic, physiological, and chemical principles underlying prevention, eradication, and control of undesired vegetation; methods of weed control available for modern agronomic, forestry, horticultural, and non-crop situations.
Prerequisite(s): BIOL 2304 and CHEM 1036
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Political Science (PSCI)

PSCI 1XXX3 - GEN ED REASONING SOCIAL SCI (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

PSCI 1004 - Nations and Nationalities (3 credits)
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1004

PSCI 1014 - Introduction to United States Government and Politics (3 credits)
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1014H - Honors Introduction to United States Government and Politics (3 credits)
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1024 - Introduction to Comparative Government and Politics (3 credits)
Government and politics of selected countries in the world: the necessity for government; the nature of politics and governmental systems; specific types of political systems; the effects and consequences of institutional designs; linkages of people and governments through political parties, interest groups, and social movements; current political issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1024

PSCI 1024H - Honors Introduction to Comparative Government and Politics (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1034 - Introduction to International Studies and Political Science (3 credits)
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, and integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing principles.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1034

PSCI 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, RLCL 1084, SOC 1084

PSCI 1114 - Introduction to Transatlantic Studies (3 credits)
Multidisciplinary analysis of core issues and topics in transatlantic studies. Origins and evolution of transatlantic interactions. Historical, political, economic, cultural (including language and literature), civilizational, religious, and societal ties binding Europe and the Americas. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1114

PSCI 1204 - Topics in Global Dialogues (1 credit)
Examination of the impact of culture in world politics. Topics under examination include: culture and global diversity; culture, identity, and order in world politics; international conflict and intercultural relations. Extensive use of case studies. May be repeated twice with different content for a maximum of three (3) credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours
Course Crosslist: IS 1204

PSCI 2014 - Introduction to Political Theory (3 credits)
Examines central themes involved in the practices of normative political theory. Topics will include critical review of the historical origins, established traditions, and major themes in normative political thinking.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 2024 - Research Methods in Political Science (3 credits)
Introduction to research in political science; formulation of theory, operationalization and measurement, gathering, analysis and interpretation of data.
Prerequisite(s): (PSCI 1014 or PSCI 1014H) and (PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 2024

PSCI 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2034, IS 2034

PSCI 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2044, IS 2044

PSCI 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2054, IS 2054

PSCI 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2064, IS 2064

PSCI 2074 - Law and Politics (3 credits)
Explores the roles of law and legal institutions within the United States. Focuses on structures and procedures of government from a constitutional perspective; the politics of law-making and law-enforcement by legislative, executive, and judicial institutions; and relationships between law and society.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 2084 - The Evolution of World Order (3 credits)
A historical and comparative study of states systems (i.e, ancient, medieval, modern, and contemporary states system). Emphasis on the globalization of the European states system, its various aspects (political, economic, cultural, religious, civilizational, and technological) and its implications for contemporary world order (i.e., the question of human equality and the impact of colonialism and post-colonialism on the question of social, political, and economic justice).
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2084

PSCI 2104 - Europe Country Analysis (3 credits)
Examination of the politics, economics, culture, society, population patterns, and history of individual European countries. Impact of individual European states' domestic affairs on their respective European sub-regions and Europe as a whole. Analysis of intra-European regional developments. Examination of differing country perspectives on European integration.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2104

PSCI 2114 - Transatlantic Political Frameworks (3 credits)
Examination of transatlantic political, security and economic institutions, such as the Organization for Economic Cooperation & Development (OECD), the North Atlantic Treaty Organization (NATO), and the Organization for Security & Cooperation in Europe (OSCE). Impact of domestic politics and external policies on the operation of transatlantic institutions. US-European relations and their impact on transatlantic institutions and European security. Bilateral political links between European and North America States (i.e., the UK-US- Canada, and France-Canada) and their impact on transatlantic relations and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2114

PSCI 2134 - Geog of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2134, IS 2134

PSCI 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 2164, CS 2164

PSCI 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2224, IS 2224

PSCI 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2484, RLCL 2484

PSCI 2954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

PSCI 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 3004 - Professionalism and Careers in Political Science and International Studies (3 credits)
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3004

PSCI 3015 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3015

PSCI 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3016, PPE 3016

PSCI 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3034, IS 3034

PSCI 3044 - The Politics of Internet Governance (3 credits)
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3044

PSCI 3054 - The Dark Web and Threat Analytics (3 credits)
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3054

PSCI 3064 - Food Politics (3 credits)
Focuses on how scholars, pundits, citizens, and policymakers think about food on local, national, and global scales. Explores various ways of producing, distributing, and consuming food and how they are implicated in specific organizations of power and possibility. Examines how food, and the discourses surrounding food, help structure understandings of a variety of issues, such as identity, property, labor, gender, race, responsibility, and death.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3064

PSCI 3104 - Security Studies: Theories and Concepts (3 credits)
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3104

PSCI 3114 - Global Security (3 credits)
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3114

PSCI 3115 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3115

PSCI 3116 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3116

PSCI 3125 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3125

PSCI 3126 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 3125 or PSCI 3125
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3126

PSCI 3134 - Global Conflict and War (3 credits)
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the present and future of war.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3134

PSCI 3135 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3135

PSCI 3136 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3136

PSCI 3144 - Global Governance and Public Policy (3 credits)
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crim. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non-governmental organizations, coalitions and corporations in global public policy-making.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3144

PSCI 3154 - Topics in Global Public Policies (3 credits)
Examines in depth selected global public policies pertaining to health, energy, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3154

PSCI 3164 - Global Trade: Structures and Policies (3 credits)
Focuses on the operations of global trading system and its structure, theories of trade in international political economy, world trading powers and international and regional trade international organizations such as the World Trade Organization (WTO), the European Union (EU), the United States-Mexico-Canada Agreement (USMC), European Union (EU), United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and their policies.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3164

PSCI 3165 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance- Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3165

PSCI 3166 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNIDO), and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance- Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3166

PSCI 3174 - Monetary Foundations of the World Economy (3 credits)
Focuses on the evolution the operations of global and structure of regional international organizations such as the International Monetary Fund (IMF) and World Bank, the global financial and monetary order. Theories of the global and monetary system in international political economy, the structure of world finance, international financial institutions, the rise of new financial powers in the world economy, central banking, monetary and financial regulation and financial crises and policy responses.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3174

PSCI 3175 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3175

PSCI 3176 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3176

PSCI 3184 - Human Security (3 credits)
Introduces the field of human security and examines the conceptual, theoretical and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and discusses its future.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3184

PSCI 3194 - Nuclear Strategy & Politics (3 credits)
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3194

PSCI 3214 - Political Participation (3 credits)
Levels and types of political participation; reasons for participation; who participates and why; effects of political activity on political processes.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3224 - Public Opinion (3 credits)
Sources and distribution of public opinion; measurement of public opinion; relationships between public opinion and public policy; institutions linking public opinion to government decisions.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3234 - Voting and Elections (3 credits)
Voting, elections, and support for political parties and party leaders in the United States and other Western democracies; impact of economic conditions on political support and patterns of realignment and dealignment.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3244 - Political Communication (3 credits)
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 3244

PSCI 3254 - Media and Politics (3 credits)
Explore the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 3254

PSCI 3255 - The Politics of Race, Ethnicity and Gender (3 credits)
Studies the status and political behavior of selected political minorities. 3255: compares African-, Mexican- and Native-Americans. 3256: examines diverse political responses to traditional gender roles, current gender issues, and the unique gender problems facing people of color.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3256 - The Politics of Race, Ethnicity and Gender (3 credits)
Studies the status and political behavior of selected political minorities. 3255: compares African-, Mexican- and Native-Americans. 3256: examines diverse political responses to traditional gender roles, current gender issues, and the unique gender problems facing people of color.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3274 - Political Parties (3 credits)
Development, organization, activities, and personnel of political parties; citizens partisan attitudes and behavior; origins, characteristics, stability, and changes of party systems.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3314 - Congress (3 credits)
Congressional structure; organization and procedure; characteristics of members of Congress; Congressional elections; decision-making and external influences; change and reform.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3324 - The Presidency (3 credits)
Election, institutionalization, staffing, relations with Congress, and the bureaucracy; initiation and implementation of public policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3334 - Judicial Process (3 credits)
Structure and functions of American legal institutions; participants in the process, impact of legal institutions on society.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3344, UAP 3344

PSCI 3354 - Constitutional Law: Structures and Relationships (3 credits)
Power and authority of president, Congress, and courts; division of powers between states and federal government.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3364 - Constitutional Law: Civil and Political Rights (3 credits)
Civil rights and liberties; rights of criminal defendants; competing conceptions of constitutional rights.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3374 - The Politics of Energy (3 credits)
Critical and humanistic perspectives of energy and its global problems. Politics and ethics of fuel extraction, distribution, and consumption across cultures and histories. Energy narratives, discourses, and aesthetics in the formation of political identities. Energy and the rise of modern democracy and global capitalism, with an emphasis on the energy dimensions of climate justice. Pre: Junior Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3374

PSCI 3384 - Politics of Global and Comparative Migration (3 credits)
Theories and politics of international migration. How policies in destination, transit, and origin countries influence migration. Why governments adopt the migration policies they do. Impacts of global, regional, and national politics and policies on migration among countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3384

PSCI 3394 - Comparative Politics of Immigrant Inclusion (3 credits)
Theories of citizenship applied across levels of government. Comparative policies for political, social, and military inclusion. Explanations for variations in policies supporting citizenship and inclusion across countries. Explanations for differences among immigrants' political inclusion across countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3394

PSCI 3414 - Public Administration (3 credits)
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3434

PSCI 3424 - State and Local Government (3 credits)
Institutions, functions, and policies of state, county, and municipal governments in the U.S.; issues confronting these governments in the federal system.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3434 - Urban Politics (3 credits)
Basic concepts of urban politics; governmental structures, policy processes, and political conflicts in U.S. cities, policy options for coping with urban problems.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3444 - Administrative Law and Policy (3 credits)
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3444

PSCI 3514 - Latin American Government and Politics (3 credits)
Introduction to the political systems of Latin American countries, including legislative-executive relations, interest groups, political parties, electoral systems, political violence, and socio-political development.
Prerequisite(s): PSCI 1014H or PSCI 1014 or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3514

PSCI 3515 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3515

PSCI 3516 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3516

PSCI 3524 - Politics of Post-Communist Systems (3 credits)
Institutions, party structures, political economy, elite politics, ethnic conflicts, leadership dynamics, and mass political behavior in Russia and other post-communist political systems.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3524

PSCI 3534 - African Government and Politics (3 credits)
Survey of major concepts and themes in the study of African politics and development: analyses of the state, political institutions, social forces, democratization, sustainable development, issues of contemporary African politics.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3534

PSCI 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc.
Prerequisite(s): PSCI 1024 or PSCI 1024H or JUD 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3544, RLCL 3544

PSCI 3554 - Comparative Political Economy (3 credits)
Economic policies and collective choice processes of pre-industrial, industrializing, and advanced industrial states; problems and crises of industrial development, economic distribution, and technological transfer in the transition from an agrarian to advanced industrial society.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3554

PSCI 3564 - Violent Political Change (3 credits)
Historical origins, political processes, and institutional outcomes of violent political change, rising from mass protest movements, revolutionary organization, military coups, and radical political parties.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3574 - Government and Politics of Japan (3 credits)
Introduction to governmental institutions, patterns of political organization and behavior, and key policies of the Japanese political system.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3574

PSCI 3584 - Governments and Politics of Asia (3 credits)
Introduction to governmental institutions, political behavior, and social and economic policy approaches of China and other selected countries in the Asian region.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3584

PSCI 3594 - Topics in Middle East Politics and International Relations (3 credits)
Government and politics of Middle Eastern states. Religion, culture and society in the Middle East. Nationalism and Middle East politics. Regional conflicts and regional security. International relations of the Middle East. Great powers and Middle East politics. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1024 or PSCI 1024 or IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3594

PSCI 3615 - International Relations (3 credits)
Structure and development of the modern international system; theories of international politics; international law; international organizations.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3615

PSCI 3616 - International Relations (3 credits)
Structure and development of the modern international system; theories of international politics; international law; international organizations.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3616

PSCI 3624 - Foreign Policy and Diplomacy (3 credits)
Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses types of diplomacy and diplomatic methods.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3624

PSCI 3625 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, public, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3625

PSCI 3626 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, public, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3626

PSCI 3634 - Human Rights: Global Issues (3 credits)
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3634

PSCI 3684 - Indigenous Peoples and World Politics (3 credits)
A survey of the historical and contemporary struggles of indigenous peoples throughout the world. Examines the dynamics of colonialism (internal and external), identity construction, gender, cultural integrity, and the ongoing global indigenous rights discourse. In addition to covering broad global processes/theoretical approaches, comparative case studies of particular indigenous groups, such as the Maasai (Kenya, Tanzania) and Mayans (Mexico, Guatemala, Belize), are used to highlight the global, regional and intra-community diversity among contemporary indigenous peoples.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3684

PSCI 3694 - Far-right Violence in the United States (3 credits)
Assessment of theoretical and conceptual foundations to understand the rise of far-right violence in the United States. Identification of causes of radicalization into the far-right. Comparison of case studies of historical and contemporary far-right violence. Evaluation of differences and similarities in historical and contemporary case studies. Appraisal of successful responses to far-right violence.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3694

PSCI 3704 - National Security Strategy (3 credits)
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3704

PSCI 3714 - The U. S. Policy Process (3 credits)
Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3714

PSCI 3724 - Poverty and Welfare Policy (3 credits)
Public policies regarding the poor, impact of current policies; future policy options.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3734 - National Security (3 credits)
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3734

PSCI 3744 - Public Policy Analysis (3 credits)
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3744

PSCI 3754 - American Political Theory (3 credits)
American political theory from the pre-Revolutionary era to the present. American contribution to the understanding of freedom, equality, political community, constitutionalism, political dissent, and the welfare state.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3764 - Contemporary Democratic Theory (3 credits)
History and critiques of classical theories of democracy; contradictions within and contemporary problems facing democracy; future of democracy according to conservative, liberal, and radical theoretical perspectives.
Prerequisite(s): PSCI 2014 and (PSCI 3015 or PHIL 3015 or PSCI 3016 or PHIL 3016)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3774 - Marxian Political Analysis (3 credits)
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3774

PSCI 3784 - Origins of the State (3 credits)
Theories of the origins of politics and government; evidence of state formation in prehistoric societies; political behavior in contemporary pre-literate societies as precursor to state formation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3795 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3795

PSCI 3796 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3796

PSCI 3804 - European Integration (3 credits)
Analysis of the process of industrial, political, legal, economic, social and cultural integration of states in Europe as a whole or within a European sub-region. History and theories of European integration. Examination of various European organizations whose actions reflect different approaches to and different degrees of integration in Europe.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3804

PSCI 3814 - The European Union: Institutions and Policies (3 credits)
Evolution, organizational structure, political dynamics, and decision-making mechanisms of the European Union. Major internal and external EU policies such as foreign, security and defense policy, economics, Single Market, and monetary union.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3814

PSCI 3824 - European Union's Foreign and Security Policy (3 credits)
The European Union (EU) as an actor in the foreign, security and defense policy fields. The external relations of the EU and its role in world affairs. The institutional arrangements of EU external relations and EU activity in policy areas including human rights, peacekeeping, environmental governance, trade, and economic development.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3824

PSCI 3825 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3825

PSCI 3826 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3826

PSCI 3834 - European Security Governance (3 credits)
Structure and function of major European security organizations, such as the North Atlantic Treaty Organization (NATO), the European Union (EU), the Organization for Security and Cooperation in Europe (OSCE), and the Collective Security Treaty Organization (CSTO). In-depth analysis of those organizations' role in the European security architecture. Examination of inter-organizational cooperation in addressing European security issues and conflicts.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3834

PSCI 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3844, IS 3844

PSCI 3854 - European Political Economy (3 credits)
The European Union's major institutions and policies relating to economic and monetary union and trade. Monetary integration, fiscal and economic policy cooperation, financial integration (including the banking union), the single market and the common commercial policy, the common agricultural policy and the EU's regional policy. The internal structure and organization of the European political economy and the external dimension of Europe and its impact on global economics, ranging from the World Trade Organization to EU enlargement and the Developing World.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3854

PSCI 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3874, MGT 3874

PSCI 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PHIL 3884, PPE 3884

PSCI 3894 - Transatlantic Relations Since 1945 (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3894

PSCI 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3914, IS 3914

PSCI 3924 - Theories of Transatlantic Relations (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3924

PSCI 3934 - NATO & European Security (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3934

PSCI 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4024 - Seminar in Diplomacy and Security (3 credits)
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4024

PSCI 4034 - Topics in Diplomacy Lab (3 credits)
Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4034

PSCI 4054 - Seminar in Global Political Economy (3 credits)
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4054

PSCI 4064 - Seminar in Global Development (3 credits)
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing worlds economic and political trajectories. Utilizes case studies, historical analysis and development economies to better understand the economic and political condition of countries in the developing world. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4064

PSCI 4074 - The Politics of Cybersecurity (3 credits)
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels.
Prerequisite(s): PSCI 3044 or IS 3044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4074

PSCI 4104 - Topics in European Studies (3 credits)
Selected issues pertaining to European Studies, such as racism in Europe, European art and society, religion and society in Europe, gender politics, and demographic trends in Europe. May be repeated twice with different content for a maximum of nine (9) credits. Pre: Senior Standing.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4104

PSCI 4144 - Topics in Transatlantic Relations (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4144

PSCI 4154 - Topics in Transatlantic Studies (3 credits)
Research and analysis of selected issues pertaining to transatlantic studies. Topics under examination include: religion and the transatlantic world; the political economy of the transatlantic slave trade; and the role of culture, language, and literature in cementing transatlantic ties. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4154

PSCI 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4164, CS 4164

PSCI 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4174, IS 4174

PSCI 4184 - Capstone Project Transatlantic Studies (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4184

PSCI 4214 - Senior Seminar in Political Behavior (3 credits)
Political behavior: socialization, voting, opinion formation and expression, decision-making in government, as explained by personality, rationality, culture, class, and institutional roles. Topics vary from semester to semester as announced. Senior standing.
Prerequisite(s): PSCI 3214 or PSCI 3224 or PSCI 3234 or PSCI 3244 or PSCI 3264 or PSCI 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4314 - Senior Seminar in Political Institutions (3 credits)
Selected topics in political institutions, including decision-making, types and structures of political institutions, internal and external influences on institutional behavior. Topics vary from semester to semester. Senior standing.
Prerequisite(s): PSCI 3314 or PSCI 3324 or PSCI 3334 or PSCI 3515 or PSCI 3516 or PSCI 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4324 - Senior Seminar in Constitutional Law (3 credits)
Cases, law review articles, and related materials containing describing, or commenting on major decisions of the U.S. Supreme Court. Topics vary from semester to semester as announced. Senior standing.
Prerequisite(s): PSCI 3354 or PSCI 3364
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4414 - Senior Seminar in Public Administration (3 credits)
Selected topics in public administration, including norms of practice, government personnel, administrative process, administrative law, privatizing, and contracting. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3414 or PSCI 3424 or PSCI 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4514 - Senior Seminar in Comparative Politics (3 credits)
Selected topics in the comparative analysis of political behavior, processes, and institutions; cross-national institutional and aggregate data analysis. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3515 or PSCI 3516 or PSCI 3524 or PSCI 3554 or PSCI 3564 or PSCI 3514 or PSCI 3534 or PSCI 3544 or PSCI 3574 or PSCI 3584
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4614 - Senior Seminar in International Relations (3 credits)
Selected topics in international relations, including objectives of national policy, dimensions and components of national power, comparative diplomacy, international conflict and cooperation, instruments for conflict resolution. Topics vary from semester to semester as announced. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3615 or PSCI 3616 or IS 3615 or IS 3616 or PSCI 3625 or PSCI 3626 or PSCI 3734 or IS 3626 or IS 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4614

PSCI 4624 - The Washington Semester: Seminar in American Politics and Public Policy (3 credits)
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4624

PSCI 4644 - Washington Semester: Politics, Policy and Administration in A Democracy (3 credits)
This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4644

PSCI 4714 - Senior Seminar in Policy Analysis (3 credits)
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3724 and PSCI 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4714

PSCI 4724 - Senior Seminar in Political Theory (3 credits)
Selected topics in analytic political philosophy, contemporary ideologies, and democratic theory. Topics vary from semester to semester as announced. Senior standing required. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3015 or PHIL 3015 or PSCI 3016 or PHIL 3016 or PSCI 3754 or PSCI 3764 or PSCI 3774 or UAP 3774
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4734 - Theories and Practices of International Conflict Management (3 credits)
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice.
Prerequisite(s): PSCI 3616 or IS 3616
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4734

PSCI 4735 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: IS 4735

PSCI 4736 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: IS 4736

PSCI 4744 - Intelligence Analysis Workshop (3 credits)
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4744

PSCI 4754 - Internship Program (1-19 credits)
Qualified students are placed in an administrative or legislative staff position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Detailed reports on the internship experience and a specific project will be required of each intern. (Variable credit to maximum of 6 credits for a full-time position over an entire semester). Three hours of appropriate advanced American government courses, Junior standing, a screening interview, GPA of 3.00 or better and consent required.
Instructional Contact Hours: Variable credit course

PSCI 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 29843 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Population Health Sciences (PHS)

PHS 1004 - Public Health First Year Experience (1 credit)
Introduction to the Department of Population Health Sciences and the Public Health curricula requirements. Introduces students to experiential learning opportunities, undergraduate research, ethical behaviors and career paths within the discipline. Exploration of programs, services and resources to enhance awareness of opportunities and support systems available for student success including academic advising and career planning. Intended for Public Health majors in their first semesters at Virginia Tech, either as incoming freshmen or transfer students.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 1514 - Personal Health (3 credits)
Fundamental health content and theory to provide students with constructive health information necessary to meet current and future personal health needs. Special emphasis on wellness and health promotion.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2004 - Introduction to Public Health (3 credits)
Examination of how public health core disciplines of epidemiology, health policy and administration, health behavior, and environmental health work together in addressing public health problems. Special emphasis on the history of public health, the public health infrastructure and role of health informatics in public health.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 3014 - Introduction to Environmental Health (3 credits)
Overview of environmental health, examining local, national, and international frameworks. Environmental factors that affect human health, including major classes of chemical, biological, and physical exposures from different environmental media (air, water, food, and soil). Special emphasis on toxicology and epidemiology methodologies used at the individual (mechanistic) level and at the population level to determine environmental causes of disease. Find the most appropriate prevention or control measure to minimize adverse health outcomes.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3044 - Global Health Issues (3 credits)
Students will get an overview of the determinants of health and how health status is measured. Students will also review the burden of disease, who is most affected by different disease burdens, risk factors, and key measures to address the burden of disease in cost-effective, doable, sustainable, and fair ways. Special attention will be paid throughout the course to health systems issues. The course will cover key concepts and frameworks but be practical in orientation. The course will be global in coverage but will focus on low- and middle-income countries, the health of the poor, and health disparities. The course will pay particular attention to the linkages between health and development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3064 - Public Health Seminar (1 credit)
Current topics in public health research, policy and practice, including biostatistics, epidemiology, health policy, environmental health, social and behavioral medicine, infectious diseases, and public health education. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 3074 - Public Health Practicum Prep (1 credit)
Preparation for the public health profession and practicum experience. Covers the necessary skills to become a successful public health professional. Students will explore and prepare for the public health practicum course by assessing interests, identifying placement opportunities, and completing necessary placement materials. Communication, ethical considerations, professional skills along with the development of resume/CV, cover letters, interviewing and networking will be covered. P/F only. Pre: Junior Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 3534 - Drug Education (3 credits)
Interpretation of multidimensional (social, psychological and physiological) scientific data regarding drugs. The major drug categories will be covered with special emphasis on substance misuse and abuse.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3634 - Epidemiologic Concepts of Health and Disease (3 credits)
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 3634

PHS 3654 - Equity in Rural Health (3 credits)
Exploration of the socioeconomic, behavioral, biological, environmental and other factors that impact human health and contribute to health disparities. Introduction to concepts surrounding rural health equity, including: (i) defining rurality; (ii) identifying social determinants of health; (iii) reviewing the history of the US public health systems and policies tasked with improving rural health; (iv) describing critical health disparities impacting rural communities (such as cardiovascular disease, cancer, mental health and substance use disorders), and the drivers of these disparities; and, (v) (v) assessing health of special populations living in rural communities, such as maternal, newborn, adolescent and child health, aging populations, migrant populations, and LGBTQ + populations (vi) discussing the assessment, planning, policies, and interventions which can be implemented to improve the health of rural communities at the population level.
Prerequisite(s): PHS 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3964 - Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4014 - Public Health Program Planning and Evaluation (3 credits)
Fundamental of public health program development, implementation and evaluation. Basic processes, approaches and interventions that identify and address the major health-related needs and concerns of populations. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4044 - Public Health Policy and Administration (3 credits)
Evolution and analysis of public health policy in the United States. Public health and care systems. Administrative concepts central to public health such as human resources, strategic planning, controlling, directing, leadership and health law. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4054 - Concepts in One Health (3 credits)
Dynamic interdependence of human, animal and environmental health; theoretical foundations of One Health; One Health research methods for assessing animal-human linkages; One Health operationalization in human medicine, veterinary medicine and public health; policies and practices related to One Health; and capacity building and public engagement; One Health and traditional Medical Model approaches to health problems. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4064 - Modeling Infectious Diseases (3 credits)
Mathematical modeling of infectious diseases; simple epidemic models, risk structure and modeling risk structure, multi-pathogen models, multi-host models, temporal seasonal models, spatial models, stochastic dynamics and modeling for public health policy. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4074 - Practicum in Public Health (2 credits)
Application of Public health theories, concepts and data in a work setting; comprehensive, structured experience requires student to demonstrate professional competencies and ethical behavior while working closely with a supervisor in a public health practice setting. Pass/Fail Only. Pre: Senior standing.
Prerequisite(s): PHS 3074
Instructional Contact Hours: (2 Lec, 2 Crd)

PHS 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4094, SOC 4094

PHS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Portuguese (PORT)

PORT 1106 - Beginning Conversational Portuguese (3 credits)
Essential vocabulary and structures of the Portuguese language as spoken in Brazil; emphasis on active spoken and written use of the language for practical daily purposes.
Instructional Contact Hours: (3 Lec, 3 Crd)

PORT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Property Management (PM)

PM 2664 - Introduction to Property Management (3 credits)
The history of residential and commercial property management, roles and responsibilities of real estate managers, developing effective management plans for properties, maintenance strategies, marketing, legal regulations that pertain to real estate management.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 2684 - Marketing and Leasing Residential Properties (3 credits)
Marketing and leasing functions for multifamily residential properties. Leasing processes, options, and online management tools. Market analysis. State and federal housing laws. Preparation for National Apartment Leasing Professional credentials.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 3634 - Managing Affordable and Specialized Housing (3 credits)
Operations management of specialized housing such as senior apartments, active adult communities, independent living communities, assisted living communities, nursing homes, affordable housing, military housing, student housing, as well as community associations and mixed-use housing developments. Consideration of consumer lifestyles, financial circumstances, and sustainability issues for each housing option.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3674 - Property Management Operations (3 credits)
Detailed investigation and analysis of the fundamentals of property management operation functions. Functions included: human resources and relationship management, maintenance and risk management, marketing and leasing, and accounting and finance. Property manager and property owner role interpretation through examination of management agreement and plan components as well as nuances among residential properties, office buildings, and shopping centers.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3684 - Sustainable Property Management (3 credits)
Comparison and justification of green alternatives during the operations and maintenance phase of the building lifecycle by function with respect to the interrelationships of the social, environmental, and economic spheres of sustainability. Course topics also include group and individual decision-making and their influences on resource use such as energy, water, and waste as well as environmental degradation concern and its influence on various stakeholders and their relationship with each other. Ethical issues as they relate to sustainable property management also covered.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4644 - Advanced Property and Asset Management (3 credits)
Examination of the competencies necessary to maximize the value of real estate assets through effective operations and financial management practices. Includes detailed examination of income maximization, financial reporting, and ownership objectives of real estate investors.
Prerequisite(s): (PM 2674 or PM 3674) and PM 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4674H - Managing and Marketing Housing for Later Life (2 credits)
Managing and marketing housing for later life, including active adult communities and assisted living facilities. Pre: Junior Standing
Instructional Contact Hours: (2 Lec, 2 Crd)

PM 4684 - Leasing Commercial Properties (3 credits)
Examination of the strategies used to market and lease various types of industrial, office and retail buildings with emphasis placed on brokerage relationships, the legal structure of commercial real estate leases, lease analytics, lease negotiations, and the impact of lease terms on the value of income-producing properties. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4694 - Contemporary Issues in Property Management (3 credits)
Issues affecting property management, including ethics, professional management decisions, legislative issues, and current management practices. The course culminates in the analysis of an apartment community and development of a management plan. Senior standing.
Prerequisite(s): PM 4964 or PM 4644
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4744 - Housing Challenges and Policies in the United States (3 credits)
Overview of the issues relating to U.S. housing policy with an emphasis on housing affordability, homeownership, fair housing and community development, and homelessness. Examination of the policy tools used to respond to housing problems at local, state and federal levels.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4914 - Residential Property Management Study Tour (1-19 credits)
Study tour that examines trends in the multifamily housing industry focusing on marketing, management, design, and customer service. Variable credit 2 credits maximum.
Instructional Contact Hours: Variable credit course

PM 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Psychology (PSYC)

PSYC 1004 - Introductory Psychology (3 credits)
The scientific study of behavior, with a focus on behavioral research methods, analysis, theoretical interpretations, and applications. Survey of brain structures and their functions, sensory mechanisms, developmental processes, classical and operant conditioning, social processes and cultural norms, approaches to psychotherapy, stress and coping, and applications of psychological science.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 1024 - Pathways Through and Beyond the Psychology Major (2 credits)
First Year Experience course introducing students to the psychology major. Discussion of university resources designed to promote student success. Emphasis on career exploration, and finding relevant research and field experiences outside the classroom.
Instructional Contact Hours: (2 Lec, 2 Crd)

PSYC 1094 - Principles of Psychological Research (3 credits)
Philosophical foundation and ethical issues in psychological research. Research design and methodology. Analytic approaches to developing, understanding, interpreting psychological data.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 1524 - Language and the Mind (3 credits)
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 1524

PSYC 2014 - Psychology of Social Interventions (3 credits)
An introduction to the psychological science that underlies behavioral interventions in non-clinical settings. Theories, methods, and applications as they relate to diverse domains such as health, education, prejudice reduction, and the environment. Methodological issues relating to intervention research in psychological science; understanding and limiting possible sources of bias. Relevance and limitations of psychological science for related public policy.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2024 - Psychology Transfer Student Course (1 credit)
First Year Experience course introducing transfer students to the psychology major. Discussion of university resources designed to promote the successful transition from another school to Virginia Tech. Emphasis on career exploration, professional development, and finding relevant research and field experiences outside the classroom.
Instructional Contact Hours: (1 Lec, 1 Crd)

PSYC 2034 - Developmental Psychology (3 credits)
Basic principles of human psychological development from the prenatal period through old age. Interactions between biological and environmental influences on the developing individual. Research methods in developmental science. Cultural influence on parenting practices, identity formation, and attitudes toward the elderly. Survey of recent literature within the areas of perceptual, cognitive, neurobiological, social, and emotional development.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2044 - Psychology of Learning (3 credits)
Survey of fundamental concepts, phenomena, and principles of learning, such as reinforcement/punishment, classical conditioning, and cognitive explanations of retention/forgetting. Traditional learning research, with particular emphasis on methodology and ethical considerations. The behaviorist perspective, and neurobiological and cognitive approaches to understanding learning. The ethical and responsible use of animal models in learning research, and practical applications of learning theory.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2054 - Psychology of Personality (3 credits)
Study of human personality and psychological adjustment: theory and research. Behavioral, cognitive, humanistic, and environmental determinants of personality. Psychological adjustment and personality development.
Prerequisite(s): PSYC 2004 or PSYC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2064 - Introduction to Neuroscience of Behavior (3 credits)
Introduction to biological factors that produce behavior. Neuroanatomy and neurophysiology. The development of the nervous system, and neuroplasticity. Basic neural processes involved in interpreting information, and making decisions. Conducting neuroscience research, and evaluating neuroscience-related claims in the popular media. The ethical and responsible use of nonhuman animal subjects; the ethical application of research findings in neuroscience to current problems such as psychopathy and neurodegenerative disease.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2074 - Animal Behavior (3 credits)
Study of animal behavior: Comparative psychology and ethology, behavioral genetics, evolution of behavior, ecological aspects of behavior, predation, reproduction, and parental care. Some consideration is given to the relevance of animal behavior to human behavior.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2084 - Social Psychology (3 credits)
Introduction to the social behavior of the individual and the group: social perception and forming judgements of others, attitude formation and change, interpersonal attraction, applied psychology. Cultural influences on attitudes toward diversity, prosocial behavior, prejudice, and aggression and conflict. Application of psychological theories and research to address current social problems.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PSYC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 3014 - Abnormal Psychology (3 credits)
Survey of various types of psychological disorders and of contrasting theoretical views and representative research on the etiology and prognosis of these disorders. Using the Diagnostic and Statistical Manual (DSM-5) to diagnose psychopathologies accurately. Ethical issues pertaining to clinical practice.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3024 - Human Behaviors and Natural Environments (3 credits)
Survey of the effects of natural and human-made environments on health and well-being. Historical changes in human-environment relations. Utilizing psychological research methods to investigate the possible impacts of urbanization on human health and well-being. The impacts of culture, region, and socioeconomics on how we utilize our environments, and our ability to change them. Research pertaining to our relationship with nature, use of natural resources, and strategies to encourage behaviors promoting environmental sustainability.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3034 - Psychological Disorders of Children (3 credits)
An examination of theory, research, and practice as related to the assessment, treatment, and prevention of psychological disorders of children. Special emphasis on the understanding of child behavior disorders from a developmental, clinical-experimental point of view.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and PSYC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3054 - Health Psychology (3 credits)
Major theories, strategies, and methods for understanding psychological contributions to health and disease; psychological approaches to the treatment and prevention of disease and unintentional injuries, and health and safety promotion.
Prerequisite(s): PSYC 2004 or PSYC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3094 - Advanced Research Methods in Psychological Science (3 credits)
Advanced research and analytical methods. Emphasis on methods for specific research and/or practical questions, critical evaluation of research publications. Extended coverage of design and analysis principles and skills, selection and completion of appropriate statistical tests for given data sets. Student-driven empirical report including literature review, methods, analysis, interpretation, and implications for future research. PSYC majors only.
Prerequisite(s): (PSYC 1094 or PSYC 2094) or STAT 3604 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4014 - History and Systems in Psychology (3 credits)
Overview of modern theories in psychology by consideration of current historical controversies. Traces roots of psychology in natural and social sciences. Considers the diversity of psychological study and the future of psychology. Senior standing in psychology required for undergraduate credit. Graduate standing required for graduate credit.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4024 - Industrial and Organizational Psychology (3 credits)
Overview of psychological theories, research findings, and methods relevant to studying the behavior of individuals in organizations. Topics covered may include prediction of job performance, personnel testing, training and development, and leadership.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4034 - Special Topics in Developmental Psychology (3 credits)
Rotating topics in the development of perceptual, cognitive, and socioemotional functioning throughout the life-span. In-depth, critical evaluation of current research literature and theory within various major age-spans. Developmental research methods, and research ethics. Cross cultural and contextual effects on development. May be repeated with different topics for a maximum of 6 credit hours.
Prerequisite(s): PSYC 1004 and PSYC 2034 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

PSYC 4044 - Advanced Learning (3 credits)
Critical analysis of basic paradigms of Pavlovian and Instrumental Conditioning with emphasis on general theories of learning and issues involved in cognition, reinforcement, and memory.
Prerequisite(s): PSYC 1004 and PSYC 2044 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4054 - Personality Research (3 credits)
Research techniques used in contemporary personality psychology: case histories, correlational methods, experimentation, archival studies, and psychobiography.
Prerequisite(s): PSYC 1004 and PSYC 2054 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4064 - Physiological Psychology (3 credits)
Presentation of concepts important for the study of neuroscience and behavior with a special emphasis on the classic topics of physiological psychology: brain-behavior relations, sensory integration, physiological correlates of motivation and emotion.
Prerequisite(s): PSYC 1004 and (PSYC 2064 or NEUR 2025) and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4074 - Sensation and Perception (3 credits)
Overview of sensory and perceptual systems and their integration in influencing behavior. Emphasis on sensory receptor characteristics, neural structure, psychophysical data, perceptual phenomena and issues, theories about the human perceptual process.
Prerequisite(s): PSYC 1004 and (PSYC 2064 or NEUR 2025) and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4084 - Advanced Social Psychology (3 credits)
Examines social behavior from four major theoretical orientations: reinforcement, field theory, cognitive, and role theory. Topics may include social learning, social exchange theories, group processes, attitude, and person perception.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and PSYC 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4094 - Theory of Psychological Measurement (3 credits)
Theory of psychological measurement and techniques used to develop and evaluate psychological measures. Coverage of standardization, measurement scales, reliability, validity, score transformations, composite scores, weighted scores, and test construction.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4114 - Cognitive Psychology (3 credits)
An experimentally-oriented survey of human cognitive processes which include attention, memory, and decision making. Role of individual difference variables in each area.
Prerequisite(s): PSYC 1004 and PSYC 2044 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4134 - Language Development (3 credits)
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono- and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4134

PSYC 4154 - Bilingual Development and Cognition (3 credits)
Survey of the process of language acquisition for children exposed to two languages during their early development. Cognitive development in children growing up in bilingual homes. Exploration of the effects of family factors, social experiences, cultural language norms, and language policies on bilingual children and adults in the current transnational environment of immigration and globalization. The effects of heritage language preservation on cultural identity and issues of equity related to linguistic discrimination in the United States.
Prerequisite(s): PSYC 1004 or PSYC 1524 or ENGL 1524 or ENGL 1504 or HD 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4184 - The Science of Giving (3 credits)
Overview of the science of giving, altruism, helping, cooperation, and prosocial behaviors and decision making. Exploration of the personality contextual, cognitive, and affective factors that move people to help others in need. Application of psychological and behavioral principles necessary to craft interventions such as nudges to increase giving with emphasis on public policy. Methodological issues related to laboratory and field experiments. Ethical considerations in persuasion and influence.
Prerequisite(s): PSYC 1094 or HD 3014 or SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4184

PSYC 4194 - Predicting Social Behavior (3 credits)
Overview of the process of predicting human choices, preferences, and actions in social contexts. Applications of measurement theory to data preparation, formatting, and scaling. Implications of psychological biases for data transformation and cleaning. Theory-guided predictor variable selection and development. Applications of machine learning to social settings. Evaluating prediction quality, bias, and generalizability. Developing predictive models in software. Ethical and societal implications of predicting human behavior.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4194

PSYC 4214 - Cognitive Psychology Laboratory (1 credit)
Design, operation, and analysis of experiments to study human cognitive processes (e.g., attention, memory, and decision-making).
Corequisite(s): PSYC 4114
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4234 - Laboratory in Developmental Psychology (1 credit)
Research design and implementation in the study of perceptual and motor development, language development, cognitive development, and social development.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and PSYC 2034
Corequisite(s): PSYC 4034
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4244 - Laboratory in Advanced Learning (1 credit)
Experimental techniques for studying the development, maintenance, and retention of behavior change in humans and animals. Laboratory exercises in Pavlovian and Instrumental Conditioning, verbal learning and memory.
Corequisite(s): PSYC 4044
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4254 - Personality Research Laboratory (1 credit)
Laboratory course in personality research techniques. Emphasis on experimental, archival, questionnaire, and psychobiographical approaches.
Corequisite(s): PSYC 4054
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4264 - Laboratory in Physiological Psychology (1 credit)
Experimental techniques in the area of physiological psychology including: handling and care of laboratory animals, anesthetic and surgical techniques, and measurement of physiological variables.
Corequisite(s): PSYC 4064
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4274 - Laboratory in Sensation and Perception (1 credit)
Overview of the major experimental techniques and phenomena of sensation and perception. Emphasis on psychophysical methods, signal detection, dark adaptation, perceptual illusions.
Corequisite(s): PSYC 4074
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4284 - Laboratory in Social Psychology (1 credit)
Design, performance, and analysis of experiments in social psychology. Various methodologies used in social research (e.g., laboratory experimentation, field observations) will be studied through actual performance of experiments.
Corequisite(s): PSYC 4084
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4294 - Laboratory in Psychological Measurement (1 credit)
Design and implementation of psychological assessment devices including issues of test construction, reliability, validity, standardizing, and detecting test bias.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and (PSYC 2094 or PSYC 1094) and (STAT 2004 or STAT 3604 or STAT 2405)
Corequisite(s): PSYC 4094
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4354 - Senior Seminar (3 credits)
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4364 - Senior Seminar (3 credits)
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4454, NEUR 4454

PSYC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PSYC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Public Relations (PR)

PR 2044 - Principles of Public Relations (3 credits)
Principles of public relations practice; public relations in organizations; responsibilities of the public relations practitioner; legal and ethical considerations; role of public relations in society; history of the field and key people who influenced its development; choosing appropriate communication channels/media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3014 - Public Relations Cases (3 credits)
Analysis of contemporary and historic public relations cases. Emphasis on theories, research techniques, planning methods, implementation strategies, evaluation standards, and ethical considerations in public relations programs and campaigns.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3034 - Topics in Public Relations and Advertising (3 credits)
Selected topics in public relations and advertising. Emphasis on theoretical, practical, or ethical issues in selected contexts. May be repeated 1 time with different content for a maximum of 6 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ADV 3034

PR 3084 - Advanced Public Relations Research Methods (3 credits)
Analysis and implementation of contemporary academic and professional research tools for public relations. Emphasis on development of research designs, assessment and evaluation of public relations programs and campaigns, and implementation of ethical research practices and standards.
Prerequisite(s): (COMM 2044 or PR 2044) and COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3144 - Writing and Editing for Public Relations (3 credits)
Advanced writing and editing used to structure and present information in public relations practice. Includes message development, message design for delivery through various media, copyediting skills and tools, strategies for dissemination, and legal and ethical issues in public relations writing.
Prerequisite(s): COMM 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3324 - Corporate Communication (3 credits)
Examines communication theories, strategies and tactics that corporations use in their public relations efforts to reach and influence publics. Prepares students for in-house public relations work and familiarizes them with expectations of corporate clients. Introduces students to the important role communication plays within and between for-profit, nonprofit, and government institutions. Emphasis on the influence of corporate culture, ethics and values on communication styles. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3334 - Public Relations and Corporate Social Responsibility (3 credits)
Explores role of communication in corporate social responsibility. Emphasis on the ethical implications of communicating the need to generate profits with the need to ensure that corporate actions do not harm important stakeholders such as employees, investors, customers, and communities.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3344 - Public Relations and Sports (3 credits)
Examines communication theories, strategies, and tactics that sports organizations use in their public relations efforts. Introduces students to the dynamic relationship between sports organizations, media, and fans. Study of ethics and professional standards in sports public relations. Emphasizes the role of public relations in sports as a strategic communication and management function.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4074 - Organizational Communication (3 credits)
Role of communication in complex organizations; communication networks, communication and management, message systems, decision-making; relationships between organizational theory and communication.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4164 - Public Relations Administration (3 credits)
Public Relations (PR) administration issues related to budgeting, strategy, legal issues, and campaigns in an organization. Emphasis on PR theory and ethics.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4304 - Public Relations Campaigns (3 credits)
Public relations campaign research, planning, implementation and evaluation. Emphasis on applying theory in campaign contexts; executing applied research; setting objectives; developing strategic plans, messages and budgets; carrying out courses of action; and evaluating results.
Prerequisite(s): COMM 2124 and (COMM 3144 or PR 3144) and (COMM 3014 or PR 3014)
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4364 - Crisis Communication and Issue Management (3 credits)
Communication theories of risk, crisis, emergency, and public/private issue management. Legal and ethical considerations in issue management and crisis communication. Communication strategies and tactics for issue and crisis management. Reputation management and image restoration as they relate to risk, crises, emergencies, and issues.
Prerequisite(s): PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4404 - Strategic Communication Capstone (3 credits)
Research and theory in strategic communication. Cultural awareness of diverse publics. Relationship, reputation, crisis, and issue management in interpersonal, group, organizational, and corporate communication contexts. Ethical standards in strategic communication. Corporate social responsibility.
Prerequisite(s): PR 2044 and AHRM 1014 and ACIS 1004 and (COMM 1016 or COMM 2004)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4414 - Public Relations Standards and Practices (3 credits)
Addresses complexities of public relations research, planning, implementation, and evaluation required for professional certification. Includes special emphasis on public relations legal and ethical practices. Senior standing.Fee $150.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

Real Estate (REAL)

REAL 1004 - Discovering Real Estate (2 credits)
First year experience for the Program in Real Estate. Academic planning, career exploration, and resources for academic success. Leadership, team building, communication and problem solving in the real estate industry. Role of ethics in the profession. Introduction to peer and professional mentors.
Instructional Contact Hours: (2 Lec, 2 Crd)

REAL 1014 - Careers in Real Estate (1 credit)
Provides an overview of multiple facets of the industry and highlights potential real estate careers. Examines academic training and specific skills needed to integrate knowledge from different real estate disciplines Provides an understanding of ethical leadership and pathways to achieve professional success through utilizing professional skills. Pre: First year or sophomore standing.
Corequisite(s): 2004 or UAP 2004.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 1024 - Real Estate: The REAL Deal! (3 credits)
Explore the dynamic world of real estate with a multifaceted understanding of the field. Delve into the history of real estate and compare the fundamentals of real estate across real estate product types. Investigate zoning and design a spatial real estate zoning plan. Differentiate strategies for financial success in real estate, while examining the influence of government on the industry. Engage in discussions that use real estate to solve complex social problems while analyzing issues of identity and equity. Debate diverse outcomes and potential future developments within the ever-evolving landscape of real estate.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2004 - Principles of Real Estate (3 credits)
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2004

REAL 2024 - Principles of Real Estate Sales (1 credit)
Preparation for the Virginia Salesperson License Exam. Residential real estate sales, mortgages and deeds of trust, types of mortgages, liens, real property management, land use controls, deed restrictions, real estate laws, mandated disclosure, property tax and Real Estate Board Regulations. Pass/Fail only.
Prerequisite(s): REAL 2004 or UAP 2004
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 2034 - Real Estate Data Analysis (3 credits)
Overview of statistical analysis for use in the real estate market. Introduction of statistical tools and skills needed to draw conclusions from the data. Understanding data, coding and preparing the data, probability and inference, and special topics in inference including insights to inform ethical management and investment decisions.
Prerequisite(s): (UAP 2004 and REAL 1014) or (UAP 2004 and FIN 2164) or (REAL 2004 and REAL 1014) or (REAL 2004 and FIN 2164) or CEE 2834
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2044 - Professional Development in Real Estate (3 credits)
Professionalism in the real estate industry including professional demeanor, interpersonal and intrapersonal skills, lifelong learning and ethics. Exposure to topics related to personal and professional development such as mentoring, networking, leadership, influencing, negotiating, personal improvement, and utilizing technology in a professional manner.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 1014 or FIN 2164)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 3024 - Applied Real Estate Development (3 credits)
Evaluate zoning and entitlements to understand the feasibility of a real estate development. Recognize the process, stakeholders, and challenges associated with developing diverse types of real estate. Use due diligence research to construct a conceptual site plan. Assess constraints and requirements to select appropriate building design elements. Recognize and implement principles of sustainability in real estate development projects. Describe fundamental principles of the construction phase of development using industry-standard terminology.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3034 - Real Estate Market Analysis (3 credits)
Identification of real estate market areas and reconciling market supply and demand for investments and developments. Applications of market analyses to product types such as residential, retail, office, industrial, hotels and resorts, and mixed-use real estate projects.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3044 - Financing Real Estate Projects (3 credits)
Methods and tools for analyzing financial performance of real estate from initial investment to disposition. Sources and uses of both debt and equity capital. Utilizing proformas to assess risks and feasibility. Budgeting for stabilized properties.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4024 - Sustainable Real Estate Development (3 credits)
Discuss principles of sustainability related to real estate development. Explore industry recognized sustainable rating systems for buildings and infrastructure. Practice project management strategies for scheduling and cost estimating a successful construction project. Identify key building systems and discuss the process for building renovation and construction. Determine the redevelopment potential of an existing site or building. Relate redevelopment principles to sustainable development. Evaluate the advantages and disadvantages of redevelopment projects based on existing conditions. Recognize the long-term economic, environmental, and social impacts of project decision making.
Prerequisite(s): REAL 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4034 - Real Estate Analytical Methods (1 credit)
Analytical approaches to contemporary topics and issues in real estate decision making. Content varies. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 4044 - Applied Real Estate Investments (3 credits)
Advanced concepts and practices in real estate investing with topics including but not limited to advanced real estate financial modeling, investment risk and return analyses, securitization, sources of funding, portfolio management, and risk management strategies.
Prerequisite(s): REAL 3024 and REAL 3034 and (REAL 3044 or FIN 4154)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4054 - Real Estate Investment Analysis (1 credit)
Analyze supply and demand to predict and model future real estate cash flows. Evaluate real estate investments using financial ratios and conduct financial risk sensitivity analysis to inform a real estate development decision. Generate formal real estate developmental reports. Participate in external real estate case competitions to further comprehension of a real estate analysis and report drafting. Restricted to REAL majors.
Corequisite(s): 3034 or 3044. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 4064 - Real Estate Appraisal (3 credits)
Application of economic principles to the valuation and appraisal of property including statistical analysis. Cost approach, sales comparison approach and income capitalization approach to conducting appraisal. Appraisal report for evaluating rural property, commercial, residential and transitional. Ethical and professional requirements. Pre: Senior standing.
Prerequisite(s): REAL 3044 or FIN 4154
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4074 - Residential Real Estate Studio (3 credits)
Course provides mock, real-world learning in a student-led environment. Design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of a residential real estate project. Select a project in consultation with faculty and industry advisors. Work on all elements of the life cycle of a residential real estate project from preliminary design through sale of the developed project.
Prerequisite(s): REAL 3024 and (REAL 3034 or MKTG 4734) and (REAL 3044 or FIN 4154)
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

REAL 4075 - Commercial Real Estate Studio (3 credits)
Couse provides mock, real-world learning in a student-led, team environment. Teams utilize knowledge from prerequisite courses. Teams undertake year-long projects where they design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of complex commercial real estate developments. Teams select projects in consultation with faculty and industry advisors. Work focuses on life cycle of real estate projects from design through sale of development. 4075: topics covered include team building, site/project selection, due diligence, initial site design and market analysis. 4076: topics covered include final site design, financing, construction, leasing and property management, and sale. For majors only, senior standing. Design/Lab Studio.
Prerequisite(s): REAL 3024 and REAL 3034
Instructional Contact Hours: (1 Lec, 2 Lab, 3 Crd)

REAL 4076 - Commercial Real Estate Studio (3 credits)
Couse provides mock, real-world learning in a student-led, team environment. Teams utilize knowledge from prerequisite courses. Teams undertake year-long projects where they design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of complex commercial real estate developments. Teams select projects in consultation with faculty and industry advisors. Work focuses on life cycle of real estate projects from design through sale of development. 4075: topics covered include team building, site/project selection, due diligence, initial site design and market analysis. 4076: topics covered include final site design, financing, construction, leasing and property management, and sale. For majors only, senior standing. Design/Lab Studio.
Prerequisite(s): (REAL 3044 or FIN 4154) and REAL 4075
Instructional Contact Hours: (1 Lec, 2 Lab, 3 Crd)

REAL 4754 - Real Estate Law (3 credits)
Fundamentals of law as it applies to real estate ownership. Rules, rights, and duties of owners of real estate. Elements of contract law and legal documents, including acquisition and disposal of property, leases, and agreements with third-party service providers. Implications for real estate taxation. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Religion and Culture (RLCL)

RLCL 1004 - Introduction to Religion and Culture (3 credits)
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1004H - Intro to Religion & Culture (3 credits)
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1014 - World Religions (3 credits)
Formation of the category of world religions in the modern West. Basic worldviews, embodied practices, and traditions included under the rubric of world religions. The encounter of and mismatch between traditions identified as world religions and the category of world religions as an instrument of colonialism and imperialism.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1024 - Judaism, Christianity, and Islam (3 credits)
Nature of religion and the analysis of it from an academic perspective. Basic tenets of Judaism, Christianity, and Islam, including their manifestations in the United States and their involvement in critical issues in a global context Interpretation of key texts from various historical and cultural contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1034 - Religion and the Modern World (3 credits)
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1034H - Religion and the Modern World (3 credits)
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1044 - Religious Ethics (3 credits)
Influential representative social and religious ethical perspectives from ancient Greek philosophers to the present; ethical reasoning on current pressing and perennial social issues - bioethics, sexuality, family, poverty--based on historical and ethical analysis of case studies; theoretical assumptions about morality as the relation between living a virtuous life and performing ethical duties.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: CRIM 1054, HUM 1054

RLCL 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, PSCI 1084, SOC 1084

RLCL 1134 - The Ancient Mediterranean World (3 credits)
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as well as their influence on later and modern cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 1134

RLCL 1214 - The Medieval World (3 credits)
Introduction to Europe and the Mediterranean world in the period between antiquity and the European encounter with the Americas. Investigation of the arts, literature, philosophy, and history of the period in the Christian, Jewish, and Islamic traditions and the multiple types of encounters that those communities experienced. Analysis of the impact the medieval world continues to have on the modern West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1504 - Introduction to Popular Culture (3 credits)
The development and formation of the category of popular culture. Competing theories and methods for analyzing popular culture. Activities, objects, and ideas included under the rubric of popular culture. Critical thinking about the production of popular culture in relation to race, gender, class, and other forms of human difference.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 1504

RLCL 1904 - Religion and Culture In Asia (3 credits)
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories religion and culture and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1904H - Religion and Culture in Asia (3 credits)
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories religion and culture and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2004 - Case Studies in Religion and Culture (3 credits)
Significant case studies in the study of religion and culture with an emphasis on influential and emerging research. Focused engagement with humanities and social sciences research grounded in analysis, comparison, and evaluation of relevant case studies.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2054 - Ethnography: Studying Culture (3 credits)
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2054

RLCL 2104 - Greek New Testament (3 credits)
Readings from the New Testament in Greek, with attention to grammatical analysis, historical background and other clues interpretation. May repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: GR 2104

RLCL 2124 - Religion in American Life (3 credits)
Understanding and integrating source materials for the study of religion in American life. Genealogy of religion and culture in America (USA). Changes and transformations in religious beliefs and practices and their influences on American life. Debates about religion and culture. Entanglements of religion, politics, race, ethnicity, and law.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2134 - Judaism: A Survey of History, Culture, and Heritage (3 credits)
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 2134

RLCL 2144 - African Religions (3 credits)
The role of religious (or belief) systems in African societies, especially the three predominant religious traditions in Africa: the so-called African Traditional Religious, Islam, and Christianity; the universe of religious systems and religious experiences and processes of Africa, in particular, Sub-Saharan Africa; critical examination of the mythic stature of Africas religions within Western cultural (and scholarly) world views and institutions.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2144

RLCL 2204 - Race and Gender in Religion and Culture (3 credits)
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social scientific approaches to investigate geographically variable historical and/or contemporary case studies.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2204, WGS 2204

RLCL 2324 - Islam (3 credits)
Addresses the rise of Islam under the Prophet Muhammad in Arabia, the development of Islam in the Middle Ages, and its resurgence in the 20th century. Issues of geographical, temporal, and ideological diversity, and critical thinking about representations of Islam in the West. Islamic orthodoxy addressed by examining the question of who represents Islam, when, and how.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2374 - Gods and Kings in Premodern India (3 credits)
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2374

RLCL 2384 - Gandhi in the Making of Modern India (3 credits)
History of India since approximately 1700, with particular focus on Gandhis influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhis role in political, social, cultural, and religious movements of the early 20th century, and Gandhis legacy in the independent states of South Asia and the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2384

RLCL 2394 - Tofu to Tikka: Food in Asian History (3 credits)
Exploration of the evolution and alterations of food and cuisines throughout Asian history. Examination of the economic, geographical, political, philosophical/religious, and social underpinnings of food in premodern Asian societies; influence of the Columbian Exchange of Asian and global cuisines; Euro-American imperialism's impact on food and society in Asia and in the European and American metropoles; emergence of national cuisines in Asia; and Asian food in the post-colonial diaspora.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2394

RLCL 2414 - Hebrew Bible/Old Testament (3 credits)
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the Hebrew Bible (Old Testament).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 2414

RLCL 2424 - New Testament (3 credits)
Introduction to the academic study of the New Testament, including gospels, Pauline materials, theological themes, and sources on the emerging church. A variety of scholarly approaches to the New Testament texts and contexts, including historical-critical, redaction critical, and literary methods. Emphasis on developing skills in critical thinking, reading, and writing about the New Testament and the ancient Mediterranean world as a way of understanding the religion and history of early Christianity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2434 - Legends of King Arthur (3 credits)
Introduction to legends of King Arthur, including stories, novels, and films from a wide historical timespan. Tales of knights, kings, and fair maidens that have entertained generations and irrevocably shaped cultural values surrounding gender relations, justice, violence, and the use and abuse of power. Analysis of individual texts and broader consideration of the Arthurian tradition during key literary-historical periods from the medieval era to the present.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2434

RLCL 2444 - Greek and Roman Myth (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2444, ENGL 2444

RLCL 2464 - Religion and Science (3 credits)
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2464

RLCL 2474 - Religion and Violence (3 credits)
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2474

RLCL 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2484, PSCI 2484

RLCL 2504 - Introduction to American Studies (3 credits)
Methodology and tools of American Studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 2504

RLCL 2514 - Asian American Experience (3 credits)
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter-generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2514

RLCL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 3014 - Women and Gender in Islam (3 credits)
An examination of women and gender in Islam from a variety perspectives including Muslim women in Islamic history, normative constructions of the role of women in Islam, and womens roles in contemporary Muslim societies. Understanding of women in classical Islam; feminist and reformist approaches; and Western constructions of the rights of women if Islam.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 3014

RLCL 3024 - Religion and Literature (3 credits)
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of religion and literature. Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3024

RLCL 3034 - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3034

RLCL 3034H - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3034H

RLCL 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3144, SOC 3144

RLCL 3204 - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3204

RLCL 3204H - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3204

RLCL 3214 - Religion and Culture in India (3 credits)
Interdisciplinary examination of the genealogy of Indian religions (including Hinduism, Buddhism, Jainism, and Sikhism) through anthropological, literary, historical, and textual source materials. Colonial construction and reform of these religions according to modern, universal European ideas of religion; how European notions of the modern nation-state, law, and religious tolerance, and European concepts of self, autonomy, community, (univocal) language, and multiculturalism impacted Indian religions. Pre-modern versus modern notions of tradition and power in Indian religions. Concepts of secularism, gender, race, conversion, caste, and religious-political identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3224 - Religion and Culture in China and Japan (3 credits)
Premodern model of Chinese and Japanese religions: interactions of various traditions (e.g. Confucianism, Buddhism, Daoism, Shinto, and folk); inseparability of religion, culture, society, and politics. Modern reinventions of religion in China and Japan in the late nineteenth and early twentieth centuries. Contemporary issues such as state-religion relations in East Asia, religions of China and Japan in America, East Asian religions and globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3404 - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3404

RLCL 3404H - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3404H

RLCL 3414 - Jesus in Earliest Christianity (3 credits)
Literary survey of the various representations of Jesus of Nazareth in canonical and apocryphal Christian literature of the first four centuries. Perspectives on Jesus and the interpretive authority involved in producing such variety. Ancient and modern interpretive frameworks for understanding the person and legacy of Jesus in earliest Christianity, including historical-critical frameworks, redaction criticism, genre criticism, and other literary methods. Analyses of modern religious/political discourses as continuations of ancient theological debates. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3424 - Orthodoxy and Heresy in Early Christianity (3 credits)
Literary survey focusing on the diversity of Christian beliefs in the first four centuries. Highlights a variety of theological debates and the historical and cultural contexts involved in the eventual production of a Christian orthodoxy, over and against so-called heresy. The history and content of early Christian texts, both canonical and apocryphal. Ancient and modern interpretive frameworks for understanding the variety and diversity of earliest Christian beliefs, including historical-critical frameworks, comparative reading, source criticism, and other literary methods. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3454 - Philosophy of Religion (3 credits)
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3454

RLCL 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3494, JUD 3494

RLCL 3504 - The Age of The Crusades (3 credits)
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3504

RLCL 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political, economy, etc.
Prerequisite(s): JUD 2134 or PSCI 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3544, PSCI 3544

RLCL 3644 - Religion in the Middle East (3 credits)
Critical issues in religion in the Middle East. Competing methods for analyzing religion in the Middle East. Key concepts relating to religion and inter-religious relations in the Middle East such as minority, majority, tolerance, citizenship, and family law. Critical thinking about the relationship between Islam and other religions with particular reference to Muslim-Jewish and Muslim-Christian relations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARBC 3644, IS 3644

RLCL 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3884, SOC 3884

RLCL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4014 - Religion and the Public Sphere (3 credits)
Debates about the resurgence of religion in the modern world. Complexities involved in defining religion. Social-scientific, phenomenological, and cultural approaches to the study of religion. Theories concerning what role religion should play in the public sphere. Theories about secularism, secularization, and the differentiation between religion and politics.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 4024 - Sociology of Religion (3 credits)
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4024

RLCL 4104 - Explorations in Advanced Humanities Topics (3 credits)
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature, philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 4104

RLCL 4324 - Topics in Religion and Culture (3 credits)
Selected topics from the religions of the world such as time and the sacred, preliterate religions, women and religion, religion and science, mysticism. May be taken three times for credit with different topics.
Prerequisite(s): RLCL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

RLCL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Residential Environment & Design (RED)

RED 1604 - Introduction to Residential Design (3 credits)
Analysis of residential spaces to meet the needs of residents. Interrelationship of residential spaces, site, and community, including climate, historic tradition, culture and impact on diversity. House construction systems and finish materials. Current and future trends in design, construction and marketing of housing for diverse households. Impact of codes and regulations on residential design and construction. Professional and labor force issues in the housing industry, interpreting residential floor plans, elevations, detail drawings.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2234 - Residential Materials (3 credits)
Identifies materials used in residential applications. Flooring, Walls, Ceilings, Trim and Textiles. Reviews properties of materials, wellness for occupants, and sustainability criteria.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2614 - Residential Construction (3 credits)
Principles of residential construction. Components, materials and methods of residential construction. Terminology used in residential construction. Interior detailing.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2624 - Residential Design I (3 credits)
Principles of residential design. Concept development using elements and principles of design. Space planning for residential environments including kitchen and bath design. Introduction to hand and computer drawing. Design Lab/Studio.
Prerequisite(s): RED 1604 or RED 2604
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 2644 - Housing and the Consumer (3 credits)
Overview of housing as it relates to consumer needs, values, lifestyles, norms and constraints. Includes structural and tenure alternatives, financial and legal considerations, house design, neighborhood choices, the home buying process, and future directions in housing. Government aspects focus on the history of federal involvement in housing, major housing programs, role of state and local government, and current housing issues and policies.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2654 - Residential Environments (3 credits)
Application of elements and principles of design in residential spaces and products from diverse cultural perspectives. Examination of human behavior theories that impact the design of residential environments. Development of residential design solutions and processes using computer aided design software. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

RED 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 3624 - Residential Design II (3 credits)
Principles of space planning and 3-dimensional design, including activity analysis and user needs, program preparation as applied to residential settings. Zoning and space planning. Design process including schematic design and design development. Design detailing. Graphic design solutions for specific areas of the home, including social, private, kitchen, and outdoor areas. Design Lab/Studio.
Prerequisite(s): RED 2624 and RED 1624
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 3644 - American Housing (3 credits)
Overview of the role of housing in family life and society throughout the history of the United States. Exploration of the impact of technology, resources, and societal values on the design and style of housing and products used in the home.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 3674 - Residential Systems (3 credits)
Residential systems such as lighting, plumbing, electrical, mechanical and security. Smart home technologies and appliances. Integration of systems into residential environments.
Prerequisite(s): RED 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4224 - Historic Preservation of Residential Properties (3 credits)
History, theory, and field methods of historic preservation in the United States such as building and site surveys, historic structures reports, and National Register Nominations; history and theory of European preservation; fundamental concepts and the role of preservation in allied disciplines; preservation in urban, town, neighborhood, and rural contexts; common preservation strategies and initiatives; understanding of community-based preservation efforts; focus on residential properties.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4604 - Environmental and Sustainability Issues in Housing (3 credits)
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4604H - Environmental and Sustainability Issues in Housing (3 credits)
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4624 - Residential Design III (3 credits)
Planning, design, and evaluation of residential spaces with an emphasis on kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people. Industry standards, best practices. Materials, fixtures, and mechanical systems. Contract documents. Design Lab/Studio.
Prerequisite(s): RED 3624
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 4624H - Advanced Kitchen and Bath Design (3 credits)
Planning, design, and evaluation of residential kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people.
Prerequisite(s): (AHRM 3624 or RED 3624) and (AHRM 3674 or RED 3674)
Instructional Contact Hours: (6 Lab, 3 Crd)

RED 4654 - Residential Design IV (3 credits)
Advanced topics in house planning, particularly kitchen and bath design, with emphasis on independent work of portfolio quality. Sustainability principles, design process, planning guidelines, design competition. May be repeated once for a maximum of 6 credits. Design Lab/Studio (5L,3C)
Prerequisite(s): RED 4624
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

RED 4664 - Universal Design (3 credits)
Application and assessment of the principles and strategies of universal design in residential and commercial environments, accessibility regulations and guidelines, products, and technologies. Demographic changes affecting global society. Disabilities and changes throughout the lifespan that affect peoples ability to interact with their environments. Marking strategies to promote universal design communities, products, environments and technologies. Methodologies to evaluate accessibility.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4664H - Universal Design (2 credits)
Evaluation and design of commercial and residential environments with consideration for accessibility, adaptation, safety, and support of the user(s).
Instructional Contact Hours: (2 Lec, 2 Crd)

RED 4764 - Universal Design Lab (1 credit)
Design of residential spaces that meet the needs of a range of users, including older adults and people with disabilities. Principles of universal design are applied to the spatial requirements and product selection for the home.
Prerequisite(s): AHRM 3624 or RED 3624
Corequisite(s): RED 4664
Instructional Contact Hours: (2 Lab, 1 Crd)

RED 4924 - Housing Study Tour (1-19 credits)
A study tour designed to examine the housing industry and trends in design, technology, products and processes. Junior standing required. May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

RED 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Russian (RUS)

RUS 1105 - Elementary Russian (3 credits)
Fundamentals of grammar, pronunciation, conversation, and reading. Respond to simple questions using appropriate grammar and syntax, participate in conversation about family, school, everyday situations, etc., write in cursive, and read adapted texts. 1105: Grammar and conversation; 1106: Grammar, conversation, and reading.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 1106 - Elementary Russian (3 credits)
Fundamentals of grammar, pronunciation, conversation, and reading. Respond to simple questions using appropriate grammar and syntax, participate in conversation about family, school, everyday situations, etc., write in cursive, and read adapted texts. 1105: Grammar and conversation; 1106: Grammar, conversation, and reading.
Prerequisite(s): RUS 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 1114 - Accelerated Elementary Russian (6 credits)
Proficiency-oriented approach to elementary Russian, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 1105 and 1106.
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 2105 - Intermediate Russian (3 credits)
Grammar, reading, conversation, and composition. Emphasizes comprehension of written and spoken Russian.
Prerequisite(s): RUS 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2106 - Intermediate Russian (3 credits)
Grammar, reading, conversation, and composition. Emphasizes comprehension of written and spoken Russian.
Prerequisite(s): RUS 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2114 - Accelerated Intermediate Russian (6 credits)
Proficiency-oriented approach to intermediate Russian for learners who wish to progress rapidly through the intermediate stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 2105 and 2106.
Prerequisite(s): RUS 1106 or RUS 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 2734 - Introduction to Russian Culture and Civilization (3 credits)
Introduction to Russian Culture and Civilization. Interactions between major political and historical events, social and artistic movements in Russia. Russian literature, art, architecture, film, and theatre in the context of Russian cultural history. Aesthetic and rhetorical strategies. Interpretation of intercultural experiences from different vantage points. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 3105 - Grammar, Composition and Conversation (3 credits)
Detailed study of grammar. Practice in written and oral expression in Russian on a variety of topics. Supplementary readings to emphasize application of grammatical principles. 3105 includes a rapid grammatical review.
Prerequisite(s): RUS 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3106 - Grammar, Composition and Conversation (3 credits)
Detailed study of grammar. Practice in written and oral expression in Russian on a variety of topics. Supplementary readings to emphasize application of grammatical principles. 3105 includes a rapid grammatical review.
Prerequisite(s): RUS 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3114 - Accelerated Advanced Russian Grammar Conversation Composition (6 credits)
Proficiency-oriented approach to advanced Russian. Daily progression through advanced Russian grammar, conversation and composition. Accelerated development of the four language modalities (speaking, listening, reading, writing) in a cultural context. Short translations and paraphrases of authentic Russian texts. Duplicates RUS 3105 and 3106.
Prerequisite(s): RUS 2106 or RUS 2114
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 3124 - Russian for Oral Proficiency (3 credits)
Devoted to the acquisition of measured levels of proficiency in speaking and understanding spoken Russian. Content-based instruction in small groups. For students who would like to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. Admission by oral exam required. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3304 - Survey of Nineteenth-Century Russian Literature in Translation (3 credits)
Masterpieces of Russian fiction and poetry written between 1815 and 1881. Romantic poetry of the early nineteenth century and traces the beginnings of Russian prose from early short stories to the rise of the novel as the dominant literary form in the second half of the century. History and politics to theological and philosophical issues in various works. Methods, terminology and practice of literary analysis. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3314 - Survey of Twentieth-Century Russian Literature in Translation (3 credits)
Masterpieces of the twentieth-century Russian literature. Symbolist, Acmeist and Futurist poetry, modernist and postmodernist prose such as Mikhail Bulgakovs The Master and Margarita, and Viktor Pelevins Life of Insects. Terminology, practice, and standard methods of literary analysis. Interactions between major political events, social and literary movement. Aesthetic and rhetorical strategies. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3424 - Topics in Russian Literature in English (3 credits)
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ENGL 3424

RUS 3434 - The Works of Vladimir Nabokov (3 credits)
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3434

RUS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4204 - Topics in Russian Culture and Civilization (3 credits)
Specific topics in Russian culture and civilization. Variable content. May be repeated for credit with different content.
Prerequisite(s): RUS 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 4304 - Studies in Russian Literature (3 credits)
Selected masterpieces of Russian literature, read in original. Lectures and discussions in Russian. May be repeated for credit with different content.
Prerequisite(s): RUS 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

School of Plant & Environmental Science (SPES)

SPES 1004 - First Year Seminar (1 credit)
Exploration of topics related to the School of Plant and Environmental Sciences from a multidisciplinary perspective focusing on communication and teamwork, problem-solving, inquiry, and digital literacy.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPES 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2004 - Cannabis - Science, Industry, and Culture (3 credits)
Major crops in the genus Cannabis (hemp and marijuana). Historical development, botanical aspects, and current research. Medicinal, recreational and industrial products and their use. Legal, cultural, political and socioeconomic issues surrounding cannabis crops.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 2244 - World Crops: Food and Culture (3 credits)
How to feed the world in 2050, world crops, primary regions of production, factors that determine where they are grown, economic importance, and use in the human diet. Linkage between food and culture, recipe preparation, and their role in defining who we are, where we come from, and what we have experienced along the way. Tracing of food migration and the African, Caribbean, Asian, Latin American, and European influence on the American cuisine. The universality of food and how every single culture and religion uses food as part of the celebration of life, death, and many cultural events.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SPES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4114 - Topics: StudyAway: Production, Culture and Social Aspects US Agriculture (3 credits)
Experiential learning, hands-on and face-to-face experience with agricultural industries involved in food production, marketing and consumption. Comparative analysis of agriculture production history, practices and constraints in different regions of the US. The course has two components. One; the in-class (onsite) discussion, analysis, and comparison of the diverse agricultural production systems between Virginia and, two; the studying “away” part (Example, California, Arizona, the Mississippi Delta). Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 4864 - Plant Sciences Capstone (2 credits)
Writing and discussion-based learning synthesizing prior knowledge gained in Plant Science degree program. Practice in science-based expository writing and speaking applied to undergraduate coursework, undergraduate research, or work-related experience in the Plant Sciences. Restricted to students in Plant Science degree program. Pre: Junior or Senior standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

SPES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

School of Pub & International Affairs (SPIA)

SPIA 1024 - Community Service Learning (3 credits)
An introduction to community service learning with emphasis on the development of civic agency. Critical perspectives on community, ethical community engagement, service and volunteerism, servant leadership, and social change. Exposure to the socio-political dynamics inherent in community development and problem solving. Includes significant community engagement and service-learning experiences, reflection, and the development of a personal community engagement action plan.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 1044 - Life in the Built Environment (3 credits)
Development of the human-made environment has shaped our social relations, culture, and identity. Discussion of how the imposition of built form has served both to define a shared culture and as a means of exclusion and injustice. Study of equity and ethics as evidenced and continued in planning, construction, and public space. Learn how the knowledge of these past structures might shape the future of the built environment in the United States in ways that are more equitable, inclusive, and sustainable.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARCH 1044

SPIA 2004 - Introduction to Urban Analytics (3 credits)
Computational and quantitative thinking applied to urban problems. Multiple data sources and tools for urban analysis. Application of computational and quantitative thinking in decision making and policy processes. Data cleaning, joining/merging, and summarizing. Evaluation of computational and quantitative thinking in urban planning and policy. Ethical and other issues related to computing, analysis and problem solving.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2024 - Community Systems Thinking (3 credits)
Introduction to systems thinking concepts and their application to community-based problem solving and decision making. Emphasis on identifying interactions between technical and contextual dimensions of persistent, complex global problems. Introduces systemic frameworks for defining problems, identifying and engaging stakeholders, ideating interventions, selecting and employing criteria for decision making, and creating feedback mechanisms for iterative design. Ethics of community engagement is considered. Includes problem- based service-learning projects.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2114 - Public Service Leadership (1 credit)
Definition and practice of leadership in the public and nonprofit sectors, and its relationship to democratic governance. Decision-making under varying degrees of certainty and ambiguity. Exploring the relationship between public values and the public interest. Evidence for decisions. Case study engagement and presentation.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPIA 2124 - The Art & Science of Negotiation (3 credits)
Practical negotiation techniques and tactics. Tools to systematically assess and prepare for negotiations, including option evaluation and understanding counterparts. Interpersonal skills for effective engagement. Multiparty negotiations. Ethical and moral issues in negotiations. Representation and principle-agent issues. Negotiation process design. Facilitation and mediation. Tackling scientifically and technically complex disputes. Various models, with an emphasis on the mutual gains approach to negotiation.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2244 - Sustainable Urbanization (3 credits)
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. Fee $30.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2244

SPIA 2314 - Active Transportation for a Healthy, Sustainable Planet (3 credits)
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2314

SPIA 2544 - Policy Dynamics in Global Health (3 credits)
Overview of global health problems and policy. Key actors and socio-political dynamics that shape knowledge and action on global health issues. Roles and responsibilities in global health policymaking.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2554 - Collaborative Policy-Making and Planning (3 credits)
Introduction to multi-stakeholder collaboration and public participation in planning, policy-making and public administration. Tools and approaches for engagement and effective collaboration. Deliberative and participatory democracy, and transparency in society. Information sharing and access. Civil society, the media and citizen activism. Ethical and moral issues in collaboration. Barriers to participation, and diversity and inclusion.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 3554 - Transdisciplinary Problem Solving for Social Issues (3 credits)
Strategies and skills for transdisciplinary problem solving. Emphasis on integrative thinking strategies and cognitive and interpersonal skills required to bridge scientific discipline-based, non-scientific discipline-based and cultural knowledge. Strategies to identify important disciplinary, non-scientific, ethical, cultural, and structural elements of a problem. Problem-based learning, ethics, team work, and effective communication skills.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 3704 - Urban Contention and Mobilization (3 credits)
Analyzes the emergence and impact of contentious mobilization in the U.S. and global cities. Includes civil and labor rights, religious freedom, democratization, and other movements for equity and inclusion. Explores social scientific approaches to mobilization, countermobilization, and collective action. Impact of contentious mobilization on governance and planning in urban sites and spaces worldwide. Examines how movements manage and address internal diversity, including variation in members' diverse experiences and objectives.
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

SPIA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4374 - Federal Cybersecurity Policy and Regulation (3 credits)
This course seeks to give students an understanding of how the government develops new cybersecurity regulations and policies that balance consumer interest in personal protection with industry attitudes towards oversight. The course also covers the policies that government entities take in the interest of national security to maintain state secrets in the face of threats from hackers and other hostile actors.
Prerequisite(s): FIN 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4454 - Future of Cities (3 credits)
Cities as complex systems. Interdependence of social, economic, environmental, and technological components and how these change over time. Theories about city formation, structure, and change, with implications for sustainability, resilience, and globalization.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4464 - Data and the Art of Policy-Making and Planning (3 credits)
Critical examination of use of scientific and technical information in planning and policy-making, exploring issues and challenges through social science lens. Investigation of appropriate and responsible use of data within collaborative and deliberative policy-making and planning processes. Presentation of data and underlying models in accessible and understandable formats. Integrating all forms of knowledge into decision-making, including local and traditional knowledge.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, HORT 4554, LAR 4554

SPIA 4724 - CyberLeaders Capstone (6 credits)
Interdisciplinary research and analysis from technical and policy standpoints of regulation and industry standards, leading to the development and communication of possible solutions for specific cybersecurity problems related to critical systems. Previous topics include cellphone encryption and Internet of Things security.
Corequisite(s): SPIA 4374
Instructional Contact Hours: (2 Lec, 12 Lab, 6 Crd)

SPIA 4784 - Community Systems Capstone (3 credits)
Collaborative community problem solving in team environments Data collection, interpretation, and presentation augment community-based, iterative design and planning processes. Consideration of ethical engagement and community goals related to social justice, resilience, and sustainability. Discourse-based project culminating in presentation of intervention proposals to stakeholders. Pre: 3 credits in Discourse.
Prerequisite(s): (SPIA 1024 or SOC 2034) and SPIA 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Science Technology Studies (STS)

STS 1504 - Introduction to Science, Technology, and Society (3 credits)
Examination of the interrelationship among science, technology, and society. Study of how science, technology, and medicine are defined and analyzed by the humanities and social sciences. Examination of topics, theories, and methods of the field of Science and Technology Studies. Depiction of the dynamics of scientific and technological controversies including the roles knowledge, expertise, risk, rhetoric and public understanding play in policy making.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

STS 2034 - Introduction to Technology and Race (3 credits)
Examination of the relationship between technology and race. Technology such as information and communication technologies, medical and biometric technologies, transportation, and space travel in contexts of colonialism, indigenous knowledge, and globalization. Role of technology in resistance and emancipation. Assessment of inequity in the design and maintenance of sociotechnical systems including bias in design, surveillance, biopolitics, and the digital divide.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2054 - Engineering Cultures (3 credits)
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2054

STS 2154 - The Life Sciences and Society (3 credits)
Basic Science, Technology, and Society (STS) perspectives on the life sciences and the ethical issues they raise. Humanistic approaches to analyze how our values and perceptions are informed by the ways that we understand bodies, biology, and life itself. How our hopes, desires, and fears shape the practices and technologies of the life sciences.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2254 - Innovation in Context (3 credits)
Critical examination of diverse definitions and examples of innovation. Discussion of innovation as a process of social change; as technology diffusion; as an economic engine; as an ecosystem; as an ideology; and more. Introduction to methods and ideas from the field of Science and Technology Studies including the analysis of innovation from historical, cultural, and economic perspectives, as well as the study of innovations consequences and its alternatives. Collaborative projects focused on creatively describing and critiquing local cases of innovative work.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2444 - Global Science and Technology Policy (3 credits)
Introduction to issues and themes in global science and technology policy, from the perspective of Science and Technology Studies (STS). Comparison of national and international policy agents, institutions, structures, and processes. Integration of key ideas from STS into policy analysis, including regulatory cultures, cultural notions of risk and expertise, large socio-technical systems, and social shaping of technology. Emphasis on international controversies, diverse cultural perspectives, and inclusion in policy processes. Cases may include international controversies over genetically modified foods, transmissible illnesses, nuclear energy, and information security.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2454 - Science, Techology, and Environment (3 credits)
Examines the nature and causes of global environmental challenges. Focuses on the role of science and technology in the causation of environmental problems and provision of solutions. Investigates uneven impacts among different groups and nations. Explores multicultural dimensions and ethical debates in the relationship between humanity and natural world. Considers visions of alternative futures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2464 - Religion and Science (3 credits)
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2464

STS 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2604, SOC 2604

STS 2664 - Technology Ethics (3 credits)
Critical, interdisciplinary exploration of ethical considerations regarding human engagements with technology, including technological development, use, success and failure. History and fundamental concepts of normative ethics and their application to specific technologies and technological systems. Emphasis on conceptualizations and representations of technology with respect to various social, cultural, and historical perspectives on nature, human nature, and technological artifacts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2715 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2715

STS 2716 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2716

STS 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2724, HIST 2724, LAHS 2724

STS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 3104 - Science and Technology in Modern Society (3 credits)
Examination of science and technology as social and cultural activities in the modern world. The relationship of science and technology to their social and cultural contexts. Institutions and values in science and technology. The changing relationship of technology to science. Discuss how the domain and objects of scientific investigation have been shaped by changing concepts of nature and the natural.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3124 - Societal Health in North America (3 credits)
Study of human health within and across a variety of geographic contexts in North America. Describe the health consequences of inequity and injustice within and across American contexts. Consider the roles of collectives, social movements, mutual aid, interdisciplinary thinking, power and social justice in addressing pathologies of power and working towards human well-being. Advocate a biosocial lens that considers the dynamic relationships between biology and environmental, social, geographic, and historical contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3124

STS 3284 - Technology and Disability (3 credits)
Technologies and the experience of disability. The ways institutions, laws, and biases influence how disability is interpreted within engineering and design culture. How disability communities resist, negotiate, adopt, make, and change technologies. Development of work on this topic through making, doing, and writing. Conversations about ableism, media portrayals, historical narratives, ideology, and rhetoric surrounding technology and disability. Includes field trips to learn about the law and assistive technology.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3314 - Medical Dilemmas and Human Experience (3 credits)
Provides a humanist perspective on dilemmas of medical ethics. Focus on the varieties of human experience of medical dilemmas. Topics include contemporary controversies, such as assisted reproduction, genetic testing and treatment, clinical trials, end-of-life interventions, and the allocation of health-care resources.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3334 - Energy and Society (3 credits)
Examines the interconnections between energy use and social life. Considers the ways that modern social institutions, such as states, cities, and households are shaped by energy systems, particularly the pervasive use of fossil fuels. Explores the influence of energy extraction and commerce on economic development and global politics. Surveys major contemporary problems related to energy, including climate change and natural resource depletion. Develops an interdisciplinary framework, drawing insights from history, sociology, and economics, for evaluating policies to transition to a sustainable energy system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3705 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3705

STS 3706 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3706

STS 3734 - History of Modern Biology (3 credits)
Exploration of the history of biology during the nineteenth century and twentieth centuries, including developments in evolutionary biology, genetics and molecular biology, biology and race, and conservation biology. Emphasis on biology's reciprocal relationship with society, how it has helped shape ideas of race and ethnicity, and the ethical dilemmas it has generated.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3734

STS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4014 - Algorithms & Society (3 credits)
This course focuses on social perspectives of algorithms and implications to factors such as class, gender, race, ethnicity, geography, and disability status. Students will be guided to think critically about the impacts of computing in society, as well as the role of social values in their design. Topics will focus on computing technologies involved in critical contemporary and global concerns including machine learning, privacy, and the infrastructure that describes the social and technical context for algorithms. Pre: Junior Standing
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4014

STS 4304 - Topics: Contemporary Issues in Science, Technology, and Society (3 credits)
Advanced introduction to social scientific concepts and methods in the study of contemporary science and technology. Examines the political, social, and cultural dimensions of a contemporary development or controversy in science and technology. Studies the relationship of science and technology to social structure, power relations, and inequality. Focuses on the institutions and organizations in which emergent science and technology are produced. Discusses policy options informed by social scientific analysis. May be repeated once with different content for a maximum of 6 credits. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

STS 4314 - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competencies, the use of narrative medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4314

STS 4314H - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 3154 or ENGL 3324
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4314H

STS 4324 - Medical Experiences and Biomedical Theories (3 credits)
Builds the analytical tools of STS and humanistic deconstruction. Challenges students to read, write, and interrogate academic literatures and real-life, immediate problems and artifacts in ethical, sociocultural, historical, and context informed ways. Builds this competence while examining materials related to current topics in health, such as but not limited to: population, development, reproductive technologies, pollution, climate change, environmental health beyond humans, and, colonialism. Employs multiple humanistic lenses including: biopolitics & biopower, intersectionality, structural and institutional analysis, syndemics, anticolonialism, violence, and disability to examine these materials.
Prerequisite(s): STS 2154 or STS 3314 or SOC 3104
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4324

STS 4334 - Sexual Medicine (3 credits)
Discusses sex and medicine in contemporary U.S. society. Explores how notions of sexual behavior and normality are defined and structured by medical discourse. Examines cultural institutions that play significant roles in formulating ideas about and definitions of deviance, perversity, and tolerated marginality. Critiques medical responses to sexual variations. Examines experiences of people who have sought out, or been the unwilling victims of, sexual medicine. Junior standing required.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 4334

STS 4704 - Gender and Science (3 credits)
Investigates the gender dimensions of science in both historical and contemporary perspectives. Discusses feminist studies of science, exploring strengths and limitations. Assess implications of cultural assumptions about gender for practicing scientists. A 3000 level course in science or engineering may satisfy the prerequisite.
Prerequisite(s): STS 1504 or WGS 2244
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 4704

STS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Science, Technology, & Law (STL)

STL 2304 - Foundations of Science, Technology and Law (3 credits)
US legal system and the rule of law; legal research, analysis, and writing; history, evolution, and moral justifications of intellectual property; intellectual property as it relates to innovative and creative activity; ethical and social issues surrounding intellectual property.
Prerequisite(s): ENGL 1106 or ENGL 1204H
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STL 4304 - Intellectual Property Law (3 credits)
Comprehensive study of the principal legal theories and moral justifications relating to the protection and infringement of intellectual property, including copyrights, patents, trademarks, and related state and federal doctrines (e.g. trade secrets); analysis of commonalities and differences between the different rights; interpretation and application of relevant statutes, rules, and cases; challenges that are posed by new technologies.
Prerequisite(s): STL 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

STL 4314 - Current Topics in Science, Technology and Law (3 credits)
Current developments, problems, and cases at the intersection of science, technology & law; particular focus is placed on intellectual property law and on social, ethical, and other legal issues prompted by new technologies and scientific advancements. Topics include copyright protection in a digital environment; patent law challenges such as patent trolls, patent thickets, ethical considerations related to patenting of life forms; design patents; innovation policy and economic considerations; intellectual property reform efforts; advanced discourse.
Prerequisite(s): STL 2304 or STL 4304 or STL 4324
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STL 4324 - Global Aspects of Intellectual Property Law (3 credits)
Comparative study of international intellectual property protection and enforcement; international treaty arrangements for copyrights, patents and trademarks; policy analysis of the globalized intellectual property system; discussion of global challenges such as access to knowledge, access to essential medicines, adequate protection of geographical indications. Pre: Senior standing.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STL 4334 - Patent Preparation and Prosecution (3 credits)
Practice of patent law, specifically procedural and substantive laws, rules, and procedures relating to patent application, patent prosecution, and patent maintenance. Filing and prosecuting patents. Ethical issues relating to patent practice. Preparation to take US Patent and Trademark Offices (USPTO) Patent Bar Examination. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

STL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Sociology (SOC)

SOC 1XXX3 - GEN ED REASONING SOCIAL SCI (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SOC 1004 - Introductory Sociology (3 credits)
Principles and basic concepts of human interaction and social organization. Basic theories and research methods, socialization, deviance, social institutions, population dynamics, social change, and social inequality by social class, race/ethnicity, gender, and sexual orientation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 1014 - Introduction to Social Anthropology (3 credits)
Introduction to basic concepts including culture and ritual, research methods especially ethnography, and theory in social anthropology for understanding human behavior. Provides a survey of anthropological approaches to language, economics, kinship, religion, identity, gender, race, politics, social organizations, and globalization that compares western and non-western cultures.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 1024 - First Year Experience in Sociology (1 credit)
Develop an identity as a sociologist and foster a sense of community with first year and transfer students in the department. Acquire research skills and an awareness of university resources that enhance academic success. Explore theories used and topics examined by sociologists and participate in sociological research. Identify careers and internship opportunities in sociology.
Instructional Contact Hours: (1 Lec, 1 Crd)

SOC 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, PSCI 1084, RLCL 1084

SOC 2004 - Social Problems (3 credits)
Examines the nature, extent, and causes of social problems in the United States and around the globe from multiple perspectives. Emphasizes the role of social structural forces including conflicting economic, racial, ethnic, national, and gender interests in the creation and perpetuation of social problems. Discussion of poverty, work, health care, drugs, terrorism, human rights, and social change.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2014 - Sociology of Intimate Relationships (3 credits)
An introduction to concepts, theories, methods, and major research findings in the sociology of intimate relationships. A description and analysis of research findings on the development, operation, and dissolution of intimate relationships, including how sociocultural and economic changes have shaped intimate relationships over time. Emphasis on the United States, including issues of diversity and inequalities in intimate relationships.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2024 - Sociology of Race and Ethnicity (3 credits)
Social construction of race and ethnicity. Relations among ethnic and racial groups. Immigration and patterns of racial and ethnic integration. Social structures and processes that perpetuate racial and ethnic stratification. Consideration of economic, social, political, and health challenges facing racial/ethnic minority groups in U.S. society. Core Curriculum approved for CLE Area 2 only when taken only in combination with AFST 1714.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2034 - Diversity and Community Engagement (3 credits)
Examination of patterns, meanings, and challenges of diversity and inclusion to improve social interactions and community engagement within a global society. Focus on diverse identities, social justice, power, and privilege, applying social science theories and concepts, to facilitate intercultural awareness. Community engagement projects employ research methods to connect course materials and service to community.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2054 - Ethnography: Studying Culture (3 credits)
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2054

SOC 2104 - Quantitative Approaches to Community Research (3 credits)
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 2104

SOC 2264 - Race, Class, Gender, and Sexualities (3 credits)
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2264, WGS 2264

SOC 2304 - Individual In Society (3 credits)
Foundation in social psychological principles of sociology including the development of the self through social interaction and intergroup processes. Factors affecting self-perceptions, ways of thinking, attitudes, emotions, behavior, and psychological well-being in social contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2404 - Deviant Behavior (3 credits)
Examines behaviors considered deviant in the United States. Explores major types of deviant behavior, such as corporate crimes, extremist groups, sexual deviance, violence, suicide, alcoholism and other drug addictions, and cyber deviance. Includes sociological theories that explain them.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2454 - Race and Racism (3 credits)
Examines theories of race and racism specifically as they relate to African Americans. We will explain conservative, neo-conservative, liberal, and progressive ideologies concerning race in past and recent United States contexts and how such theories emerged and continue to emerge in recent times. Though the majority of the course focuses on race and racism within the U.S comparative analyses will be made with Brazil and South Africa.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2454

SOC 2514 - Asian American Experience (3 credits)
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter-generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2514

SOC 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2604, STS 2604

SOC 2744 - Black Food in the US: Race, Racism, and Food Studies (3 credits)
A survey of the relationship between Black people in the United States with respect to food, culture, and society. Specifically covers Black food narratives, practices, space, place, as well as issues of inequality and exploitation within society.
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 3004 - Social Inequality (3 credits)
Class, status, and power in society. Theories and empirical research findings on vertical and horizontal stratification in society. Class differences in behavior, values, and avenues and extent of social mobility. Cross cultural comparisons.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3014 - Gender Relations (3 credits)
Focus on the social construction of gender relations. Examines how gender relations vary cross-culturally, historically, and for different categories of men and women. Explores the causes and consequences of inequality and privilege. Attention paid to the ways race, ethnicity, class, age, and sexualities shape and are shaped by gender and the relationship of gender to social institutions.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3104 - Sociological Theory (3 credits)
Focus on the development and contemporary state of sociological theory. Primary concern is with those theorists who have had significant impact on our thinking about the relationships among man, society, and nature.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3144, RLCL 3144

SOC 3204 - Social Research Methods (4 credits)
Techniques of data collection and analysis employed in the social sciences with emphasis on survey research methods including questionnaire construction, sampling, and analysis of both self-collected and national data; logic behind application of these techniques.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (4 Lec, 4 Crd)

SOC 3314 - Social Movements (3 credits)
The study of collective attempts to address social injustices and implement other social change in and across societies. Explores sociological and interdisciplinary conceptions of social movements and their relationships to society. Social movement emergence, development, engagement with opponents and authorities, and impact, as shaped by opportunity structures, mobilizing structures and processes, framing, collective identity, strategy and tactics, and other factors. How social movements oppose or promote inequality, oppression, or violence in the U.S. or elsewhere, at the local, national, and transnational level. Application of political process and other current social movement theories.
Prerequisite(s): SOC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3404 - Environmental Justice (3 credits)
Causes and consequences of environmental and climate injustices; interactions between social inequalities (race, gender, class, position in world-system) and environmental pollution, food and land injustice, climate injustice, and environmental health; environmental racism in environmental policies and practices; political-economic barriers to achieving environmental justice; evaluation of environmental justice reforms and sustainability initiatives; possibilities for system change; social movement strategies for achieving environmental and climate justice; case studies in environmental justice and injustice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, HUM 3464, UAP 3464

SOC 3504 - Population Trends and Issues (3 credits)
Contemporary American and global population trends in historical and comparative perspective. Discussion of the impact of population change on individual and society. Relevant public policy questions examined.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3614 - Gender and Work in the U.S. (3 credits)
Examination of the role that gender plays in shaping the experience of work, focusing especially on the persistence of occupational segregation by sex, its causes and implications. Also, the interaction of work and family life, including the allocation of household work and control of resources. Social policies affecting gender relations in work organizations will be analyzed.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3714 - Sociology of Aging (3 credits)
Emergence of old age as a social problem. Social aspects of aging in America, including the minority experience and with some cross-cultural comparisons. Social and demographic characteristics of the aged, location of aged in the social structure, and current and future social problems of old age.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3854 - Globalization: Sociological Perspectives (3 credits)
Distinguishes global from international. Examines social globalization and cultural globalization and what forms they take. Explores changes in the role of nation-states and the implications of global changes in the division of labor for economic, gender, and racial/ethnic inequalities. Discusses how globalization is linked with peace, violence, and human rights. Considers alternative and more equitable forms of globalizations and how social movements might lead to such alternatives.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3884, RLCL 3884

SOC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4014 - Sociology of the Family (3 credits)
The family as a basic social institution: similarities and variations in family systems, their interrelationships with other social institutions, and patterns of continuity and change. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4024 - Sociology of Religion (3 credits)
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 4024

SOC 4034 - Sociology of Education (3 credits)
Analysis of the structure, functions, and consequences of schooling in America, the social processes affecting academic achievement, and the implications of current knowledge for educational reform. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4044 - Military Sociology (3 credits)
The military institution and its relationship to society. Emphasis on the role of the military and its social organization; recruitment, socialization, career, combat, deviant behavior, changes in the military, and future trends. Taught alternate years. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4054 - Appalachian Languages and Cultures (3 credits)
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4034

SOC 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4094, PHS 4094

SOC 4114 - The Sociology of Popular Music (3 credits)
Examine the social context(s) of popular music, including the social, economic, and political factors that influence the development of different popular music forms; authenticity within popular music genres; popular musics impact on social activity and identity; the institutions that connect popular music producers with consumers.
Prerequisite(s): SOC 1004 and SOC 1014 or AFST 1714
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4124 - Topics in Culture (3 credits)
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the cultural of the nineteen sixties. Course may be repeated with different course content for up to 6 credits. Pre: Junior or Senior standing.
Prerequisite(s): SOC 1004 or SOC 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: HUM 4124

SOC 4194 - Senior Seminar (3 credits)
Required seminar for majors. Integration and application of prior coursework, including reviews of theory and research methods. Application of sociological knowledge toward an actual needs assessment in a work setting, completion of a social policy analysis, and a written critique of a sociological publication. Course serves as a bridge to graduate study, prepares students for application of sociological knowledge, and provides overall career guidance. Senior standing and sociology majors only.
Prerequisite(s): SOC 3104 and SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4204 - Applied Research (3 credits)
Stresses differences between applied research and other methodologies. Examines the topics, purposes, problems, theories, and methods appropriate for applied research. Explores ethical and political issues prevalent in applied settings. Includes qualitative, quantitative, and mixed methodologies. Emphasis on survey construction and administration, experimental designs, evaluation research, and participatory action research as used by applied researchers. Includes data analysis and issues of presenting applied research to lay audiences.
Prerequisite(s): SOC 3204 and STAT 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4294 - Capstone: Diversity Engagement (3 credits)
In-depth examination of core themes of diversity. Explains patterns and relational/intersectional aspects of diversity, including the history and legacies of inclusion and exclusion, from a variety of perspectives. Synthesizes diverse writings on issues of social justice and community, power and privilege. Uses social science theories and concepts of diversity to examine contemporary issues of diversity and to facilitate and interpret community engagement projects based in students major fields of study. Focuses on collective responsibility to eliminate bias and discrimination through students community-based project outcomes. This course is restricted to students who have enrolled in the Diversity and Community Engagement Minor.
Prerequisite(s): SOC 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4304 - Research Methods Topics (3 credits)
Variable topics course that focuses on different research methodologies. Includes topics such as feminist research, qualitative methodologies, survey design, evaluation research, and anthropological methods. Can be taken multiple times if different topic.
Prerequisite(s): SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

SOC 4324 - Medical Experiences and Biomedical Theories (3 credits)
Builds the analytical tools of STS and humanistic deconstruction. Challenges students to read, write, and interrogate academic literatures and real-life, immediate problems and artifacts in ethical, sociocultural, historical, and context informed ways. Builds this competence while examining materials related to current topics in health, such as but not limited to: population, development, reproductive technologies, pollution, climate change, environmental health beyond humans, and, colonialism. Employs multiple humanistic lenses including: biopolitics & biopower, intersectionality, structural and institutional analysis, syndemics, anticolonialism, violence, and disability to examine these materials.
Prerequisite(s): STS 2154 or STS 3314 or SOC 3104
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4324

SOC 4404 - Sociology of Law (3 credits)
The functions of law as a form of social control. The social forces in the creation, enforcement, and change of the law. The nature of law as a force in social change. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4414 - Drugs and Society (3 credits)
Examines the use of drugs, including legal and illegal drugs, from a sociological perspective. Cross-cultural and historical patterns of use are discussed and explained. Particular attention is given to drug use within the context of various social institutions. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4444 - Schools, Violence, and Justice (3 credits)
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students rights/responsibilities.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4444

SOC 4454 - Topics in Sociology (3 credits)
A variable topics course in sociology. In-depth examination of topics such as environmental sociology, the sociology of sport and competition, social networks, and sociology of the body. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

SOC 4704 - Medical Sociology (3 credits)
Social and cultural response to illness and infirmity. Emphasis on the sick role, patient role, practitioner role, organization and politics of health care delivery, stratification, professionalism, and socialization of health practitioners. Taught alternate years. Junior Standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4714 - Sociology of Mental Illness (3 credits)
Mental illness and social systems, historically and in contemporary society. Distribution of mental illness with special reference to stratification, role, and deviance theories. Mental health occupations and organization of treatment. Implications for social policy. Taught alternate years. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4754 - Internship (1-3 credits)
Placement and sociologically relevant work in one of a variety of human service settings, combined with relevant readings, discussion and written work coordinated jointly by a faculty member and the setting supervisor. Placement settings include human resource agencies, corrections facilities, extension offices, and law agencies. Sociology major or minor required. Junior or Senior standing required. Consent of internship coordinator required. Coursework relevant to placement setting.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

SOC 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4764, UAP 4764

SOC 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Spanish (SPAN)

SPAN 1105 - Elementary Spanish (3 credits)
Fundamentals of grammar, composition, and oral skills. Readings carefully selected for comprehension and simple conversation. 1105 for students with no high school Spanish; 1106 for students who have completed 1105 or who have less than three years of high school Spanish.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 1106 - Elementary Spanish (3 credits)
Fundamentals of grammar, composition, and oral skills. Readings carefully selected for comprehension and simple conversation. 1105 for students with no high school Spanish; 1106 for students who have completed 1105 or who have less than three years of high school Spanish.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 1114 - Accelerated Elementary Spanish (4 credits)
Condenses SPAN 1105 and 1106. Proficiency-oriented approach to elementary Spanish, designed for learners with some prior experience in the language or for those who wish to progress rapidly through the beginning stages of language learning. Supplemented with a self-instructional electronic component. Meets University and college foreign language requirement. SPAN 1114 duplicates SPAN 1106.
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

SPAN 2105 - Intermediate Spanish (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2106 - Intermediate Spanish (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): SPAN 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2114 - Accelerated Intermediate Spanish (6 credits)
Proficiency-oriented approach to intermediate Spanish, designed for learners who wish to progress rapidly through the intermediate stages of language learning. Review of grammar with increasing emphasis on reading, writing, listening, and oral communication. Study of authentic materials and cultural artifacts in Spanish. Study of cultures, traditions, customs, and social conventions of the Spanish-speaking world. Not recommended for native speakers of Spanish. Accelerated version of 2105-2106. Duplicates 2105-2106.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

SPAN 2124 - Intermediate Spanish for Building Construction (3 credits)
Proficiency-oriented approach to intermediate Spanish, designed for learners who wish to incorporate building construction topics at the intermediate stage of language learning. Review of grammar with increasing emphasis on reading, writing, listening, and oral communication applied to the field of Building Construction. Study of authentic materials related to personal and professional situations in the field of Building Construction. Development of communication strategies for risk assessment, health concerns, and basic instructions with Spanish-speaking workers in Building Construction. Duplicates Spanish 2105 Intermediate Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2744 - Topics in Spanish Culture (3 credits)
Examines fundamental concepts related to Spanish culture within a specific historical and geographical context. Interprets cultural artifacts of the period across selected genres, including drama, poetry, film, and/or art. Analyzes how cultural identity is constructed by multiple and diverse disciplinary perspectives and in response to global challenges and opportunities. Taught in English. Repeatable with different topics for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 2754 - Topics in Spanish American Culture (3 credits)
Examination of fundamental concepts related to Spanish American culture in variable historical and geographical contexts through the study of one or more of the following: narrative; essay; drama; poetry; film; and art. Emphasis on the interpretation and analysis of cultural texts and other creative artifacts in the context of key historical and political events, in order to understand shifting concepts of cultural identity, advantages and challenges of diversity and inclusion, and global challenges and opportunities in the human world. Taught in English. Course may be repeated, with different topics, for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 2764 - Introduction to Latino American Studies (3 credits)
Introduction to interdisciplinary field of Latino American Studies. Exploration of debates and problems of Latin American and Latina/o history and culture. Examination and analysis of transnational, social, and cultural trends. Emphasis on connections between United States and Latin America, and local and regional Latina/o communities. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2774 - Minority Languages in the Spanish-Speaking Context (3 credits)
Examination of language policies and practices with regard to minority languages across the Spanish-speaking context, histories of minority languages in Spanish-speaking areas, and the current socio-political situations of these languages and their speakers. Exploration of issues concerning linguistic rights, such as access to education, economic opportunities, and political status; analysis of the implications of restrictions on minority groups linguistic rights. Discussion of why some minority-language speakers have been more successful in their language conservation or revitalization efforts than others. Taught in English. Does not count toward the Spanish major or minor.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 3105 - Grammar, Composition and Conversation (3 credits)
3105: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish. 3106: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 2106
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3106 - Grammar, Composition and Conversation (3 credits)
3105: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish. 3106: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 2106
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3125 - Spanish for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken Spanish. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3126 - Spanish for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken Spanish. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3154 - Spanish for the Natural Sciences (3 credits)
Knowledge of the Spanish language and its cultures to the natural sciences. Study of scientific materials in Spanish. Practice in communication skills through contextualized use of specific vocabulary, idiomatic expressions, grammar structures and cultural practices in real-world situations. Discussion on scientific topics and debates of the Spanish-speaking world. Comparison of the practices and world views of scientists and clinicians in Hispanic and English-speaking countries. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3224 - Topics in Latinx Culture (3 credits)
Transdisciplinary examination of fundamental concepts related to Latinx/Hispanic culture—among these, cultural hybridity, multilingualism, civil rights, activism, social justice, and marginalization—in variable cultural, historical, political, and geographical contexts. Study of one or more of the following: narrative, essay, drama, poetry, popular media and works of art. Emphasis on the interpretation and analysis of texts and other creative artifacts to understand Latinx culture's intersections with race, ethnicity, gender, sexuality, class, religion, indigeneity, nationality, disability, etc., challenges of diversity and inclusion, and the sociopolitical issues affecting those who identify as Latinx or Hispanic in the United States. Course may be repeated, with different topics, for a maximum of 6 credits. Taught in English.
Prerequisite(s): SPAN 2764 or SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 3304 - Introduction to Hispanic Literature (3 credits)
Introduction to Hispanic literary genres (poetry, narrative, essay, and drama) through analysis and discussion of the main historical, political and cultural concepts of Hispanic Literature from Spain and Latin America from the Middle Ages to the present. Identification of issues of diversity (race, gender, and social class) in the Spanish-speaking world. Methods, terminology, and practice of literary analysis. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3404 - Early Peninsular Culture and Literature (3 credits)
Examination of the culture and literature of Spain from the 9th century to the 18th century, including historical documents, narrative, poetry, theatre, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events. Examination of multiple levels of cultural identity, including advantages and challenges of diversity, found within the Iberian peninsula during that time frame. Reflection on similarities of intercultural exchange in medieval Spain and our own age. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3414 - Modern Peninsular Culture and Literature (3 credits)
Examination of the culture and literature of Spain from 1700 to the present, including narrative, poetry, theatre, film, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events, in order to understand shifting concepts of cultural identity and advantages and challenges of diversity. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3444 - Early Spanish-American Culture and Literature (3 credits)
Exploration of the cultural development of Spanish America from the pre-Hispanic era, the Encounter, the three hundred years of colonialism to Independence from Spain and nation- building in the 19th century; analysis of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, art, architecture and music; interpret intercultural experiences from ones own worldview. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3464 - Topics in Modern Mexican and Central American Cultures (3 credits)
Interdisciplinary exploration of concepts of Mexican and Central American cultures from the post-independence periods to the present. Analysis of cultural production within the historical, political, social, and intellectual contexts in which they were created. Interpretation of canonical and non-canonical texts, including historical texts, narratives, poetry, drama, film, art, architecture, and music. Analysis of current events and identification of changes brought on by globalization from an intercultural point of view. Articulation of advantages and challenges of cultural diversity. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3474 - Modern Spanish-Caribbean Culture and Literature (3 credits)
Exploration of the civilization, culture, and literature of the Spanish Carribbean, spanning the 19th century post- independence period to the present; analysis of literary and cultural texts within the historical, political, and social context in which they were created; interpretation of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3484 - Modern Andean and Southern Cone Culture and Literature (3 credits)
Exploration of the civilization, culture and literature of the Andean and Southern Cone regions of South America, spanning the 19th century post-independence period to the present; examination of literary and cultural texts with the historical, political, and social context in which they were created; study of canonical as well as non-canonical texts, from both high and popular culture, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Tuaght in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3494 - Introduction to Hispanic Linguistics (3 credits)
Introduction to fundamental concepts of Hispanic linguistics. Examination of linguistic properties in Spanish (e.g.,morphology, syntax, and semantics/pragmatics). Exploration of context-appropriate language use. Interpret experiences with language from different perspectives. Examination of complexities of cross-cultural communication. In Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3514 - Spanish for Medical Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the medical professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats. Cross-cultural discussions on healthcare issues in the Hispanic world. Analysis of medical topics related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural and linguistic diversity in the medical professions. Analysis of political and cultural history of the Hispanic and Latino populations in the US. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3524 - Introduction to Spanish Translation (3 credits)
Introduction to the translation of various types of texts, such as literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language. Taught in Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3534 - Spanish for Business Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the business professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats such as cover letters and business memos. Discussion on cultures of business in the Hispanic world. Analysis of business topics related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural and linguistic diversity in the business professions. Analysis of economic and political history of Spanish-speaking populations. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3544 - Sounds of Spanish (3 credits)
Provides students with an overview of phonetics and phonology in Spanish and familiarizes students with the articulatory descriptions of vowels and consonants of Spanish. Compares and contrasts the sound systems of Spanish and English. Analyzes the sound system using theories and methods in linguistics. Explores the social meaning of the phonetic variation that exists throughout the Spanish-speaking world. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3554 - Teaching Spanish (3 credits)
Examination of theories and approaches to second-language and heritage-language learning and teaching. Discussion of technological resources and authentic materials that promote language teaching and individual differences that affect language learning. Analysis of pedagogical materials for the Spanish-language classroom. Hands-on experience with lesson-plan design for teaching Spanish. Taught in Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3564 - Community through Service: Latino NRV (3 credits)
A service-learning course in Spanish. Exploration of Latino cultures in the U.S.; weekly service with members of local Latino communities who have requested help; reflection on community work and student citizenship; exploration of cultural factors involved in the construction of community, including the challenges of immigration, multiculturalism, and multilingualism within the U.S.; analysis of literary readings, films, and works of art from U.S. Latino communities; discussion of readings on Hispanic migrations and border studies, as well as articles on social privilege, service-learning, education, health care, language, and language learning. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3574 - Spanish for Legal Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the legal professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats. Cross-cultural discussions on legal issues in the Hispanic world. Analysis of legal topics and concepts related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural, ethical, and linguistic diversity in the legal professions. Analysis of political and cultural history of the Hispanic and Latino populations in the US. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4104 - Advanced Grammar and Style (3 credits)
Analysis of and practice with advanced grammatical and stylistic concepts, including idiomatic and colloquial usage. Intended to help advanced students achieve high levels of proficiency in writing and speaking Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4114 - Topics in Spanish Linguistics (3 credits)
Variable content course that surveys linguistic concepts and methods as related to the Spanish language. Topics may include the study of the phonology, morphology, syntax, and semantics of Spanish; the pedagogical application of these language systems; the psychological and social context of language; and the development of Spanish from its origins to its modern form. May be repeated for credit with different content.
Prerequisite(s): SPAN 3494 or SPAN 3544
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4124 - Spanish Translation: Theory and Technique (3 credits)
Introduction to translation theories and application of these theories to different types of texts, including literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language.
Prerequisite(s): SPAN 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4304 - Topics in Early Modern Literature and Culture (3 credits)
Variable topics in Hispanic and/or Latin American literature and culture of the Early Modern period. Texts and/or cultural artifacts selected for aesthetic value, historical importance and thematic significance. Related scholarly criticism representing a variety of approaches. Emphasis on historical, social and cultural context. May be repeated twice for credit with different content. Taught in Spanish.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 4314 - Studies in 18th and 19th Century Literature (3 credits)
A variable content course devoted to Hispanic literature of the 18th and 19th centuries. The texts selected are studied not only for their aesthetic value but also in terms of their historical and cultural significance. May be taken twice for credit with different content. Taught alternate years. I
Prerequisite(s): SPAN 3414 or SPAN 3404 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4324 - Studies in 20th and 21st Century Hispanic Literature (3 credits)
A variable content course devoted to Hispanic literature of the 20th and 21st centuries. Offers an in-depth literary exploration of a significant historical period, cultural movement, theme, or genre. Focuses on literary and cultural analysis from a variety of perspectives. Practices advanced Spanish oral and writing skills. Examines texts that have aesthetic value and historical and cultural significance. May be taken up to three times for credit with different content.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 3 credit hours

SPAN 4334 - Special Topics in Hispanic Life, Literature, and Language (3 credits)
Broad central themes of Hispanic culture as manifested in creative and historical literature, music, art, film, etc., or in language, such as the history of the Spanish language, translation techniques, or the staging of dramatic works in Spanish. Historical and/or national boundaries are crossed whenever the nature of the topic permits. May be repeated for credit with different content. Taught alternate years.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4344 - Hispanic Literature and the Representation of History (3 credits)
Focuses on the relationship between history and literature in the Hispanic world through an interdisciplinary lens. Examines different geographical regions of the Hispanic world, theoretical readings, and the ways that authors have used various literary styles to portray, re-write, subvert, and even contradict their countries official history. Examines texts that have aesthetic value and historical and cultural significance. Practices advanced Spanish oral and writing skills. This variable topics course may be repeated up to three times if topics are different.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

SPAN 4794 - Senior Tutorial in Spanish Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level Spanish course required. Restricted to Seniors. Restricted to Spanish majors. Consent of Spanish Section required.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPAN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4964H - Field Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

SPAN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Statistics (STAT)

STAT 1004 - The First Year Experience in Learning from Data (2 credits)
Introduction to the field of statistics and aspects of college life for first year students. Topics included: history of the statistics; key roles of statisticians in field, such as actuarial sciences, pharmaceutical, medical, and bioinformatics industries, governmental agencies, academia; fundamental principles of statistical fields of study and applications; exploring data sets; and aspects of college life for first-year students.
Instructional Contact Hours: (2 Lec, 2 Crd)

STAT 1014 - Data in Our Lives (3 credits)
Develop and practice the process of thinking critically with data in the context of real world problems. Import, manage, summarize, and visualize data using programmable, statistical software. Make data discoveries, make decisions, generate hypotheses, and/or communicate findings in data. Consider laws of probability and personal biases to weigh decisions. Recognize ethical issues and vulnerabilities in analyses when learning from data and extrapolating to large populations.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2004 - Introductory Statistics (3 credits)
Fundamental concepts and methods of statistics with emphasis on interpretation of statistical arguments and statistical reasoning. Using modern, accessible statistical software and technology, an introduction to design of experiments (including data collection), data analysis, data visualization, correlation and regression, concepts of probability theory, sampling errors, confidence intervals, and hypothesis tests. Include real-world applications to develop problem-solving skills and consider ethical implications within the context of learning from data. No credit will be given for 2004 if taken with or after any other statistics course, except STAT 2984.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 2094 - Basic R for Statistics (1 credit)
Introduction to R/RStudio programming techniques with an emphasis on basic statistical visualizations, descriptive and summary statistics, and elementary inferential statistics. Topics include data types, data structures, importing/exporting, and manipulating datasets, functions, packages, and RMarkdown.
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 2274 - Basic Python For Statistics (1 credit)
Use of Python code and libraries (SciPy and NumPy) to support basic statistical tasks, create graphical displays, and perform statistical inference and hypothesis tests to evaluate datasets. Use of editors and AI to generate Python code.
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

STAT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2984O - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

STAT 3005 - Statistical Methods (3 credits)
3005: Basic statistical methodology: exploratory data techniques, estimation, inference, comparative analysis by parametric, nonparametric, and robust procedures. Analysis of variance (one-way), multiple comparisons, and categorical data. Includes real-world examples. Develops problem-solving skills and ethical reasoning within the context of learning from data. 3006: Analysis of variance, simple and multiple, linear and nonlinear regression, analysis of covariance. Use of MINITAB. STAT 3005 duplicates STAT 3615 and STAT 4604, only one may be taken for credit. STAT 3006 duplicates STAT 3616, STAT 4604 and STAT 4706, only one may be taken for credit.
Prerequisite(s): MATH 1225
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3006 - Statistical Methods (3 credits)
3005: Basic statistical methodology: exploratory data techniques, estimation, inference, comparative analysis by parametric, nonparametric, and robust procedures. Analysis of variance (one-way), multiple comparisons, and categorical data. Includes real-world examples. Develops problem-solving skills and ethical reasoning within the context of learning from data. 3006: Analysis of variance, simple and multiple, linear and nonlinear regression, analysis of covariance. Use of MINITAB. STAT 3005 duplicates STAT 3615 and STAT 4604, only one may be taken for credit. STAT 3006 duplicates STAT 3616, STAT 4604 and STAT 4706, only one may be taken for credit.
Prerequisite(s): STAT 3005 or STAT 4705 or CMDA 2005
Corequisite(s): MATH 1206 or MATH 1226 for 3005.
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3094 - SAS Programming (3 credits)
Introduction to basic programming techniques: creating DATA and PROC statements, libraries, functions, programming syntax and formats. Other topics include loops, SAS Macros and PROC IML. Emphasis is placed on using these tools for statistical analyses. The pre-requisite may be substituted for an equivalent course.
Prerequisite(s): STAT 3005 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3104 - Probability and Distributions (3 credits)
Probability theory, including set theoretic and combinatorial concepts; in-depth treatment of discrete random variables and distributions, with some introduction to continuous random variables; introduction to estimation and hypothesis testing.
Prerequisite(s): (MATH 1226 or MATH 1026) and (STAT 3005 or STAT 3615 or STAT 4705 or CMDA 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3204 - Data Visualization (3 credits)
Using quantitative and qualitative thinking to develop a working knowledge of data visualization considerations, methods and techniques that lead to: understanding the audience(s); creating ethical data stories; data visualization as a method of storytelling; ethical and appropriate data exploration, manipulation, and cleaning; design considerations; types of visualizations; tools and resources for creating visualizations.
Prerequisite(s): (STAT 1014 or STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or STAT 4705 or STAT 4706 or STAT 4714 or CMDA 2005 or CMDA 2014) and (COMM 1016 or ENGL 1105)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3274 - Introduction to Sports Analytics Research (3 credits)
Introduction to sports analytics, sources of sports analytics data and data collection methods, visualization techniques, game performance statistics, inferential statistics and predictive modeling techniques for sports data. Role and applications of data analytics in the sports industry.
Prerequisite(s): CMDA 2006 or STAT 3006
Corequisite(s): CMDA 3654 or CS 3654 or STAT 3654.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3274

STAT 3504 - Nonparametric Statistics (3 credits)
Statistical methodology based on ranks, empirical distributions, and runs. One and two sample tests, ANOVA, correlation, goodness of fit, and rank regression, R-estimates and confidence intervals. Comparisons with classical parametric methods. Emphasis on assumptions and interpretation.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4604 or STAT 4706 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3604 - Statistics for Social Science (3 credits)
Statistical methods for nominal, ordinal, and interval levels of measurement. Topics include descriptive statistics, elements of probability, discrete and continuous distributions, one and two sample tests, measures of association. Emphasis on comparison of methods and interpretations at different measurement levels. Includes real-world applications to develop problem-solving skills and ethical reasoning within the context of learning from data.
Prerequisite(s): MATH 1014 or MATH 1025 or MATH 1214 or MATH 1225 or MATH 1524
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3615 - Biological Statistics (3 credits)
Descriptive and inferential statistics in a biological context with real-world examples. In analytical contexts, develops problem-solving skills and ethical reasoning. 3615: Fundamental principles, one- and two-sample parametric inference, simple linear regression, frequency data. 3616: One- and two-way ANOVA, multiple regression, correlation, nonparametrics, using a computer package. STAT 3615 partially duplicates STAT 3005 and STAT 4604, only one may be taken for credit. STAT 3616 partially duplicates STAT 3006, 4604 and 4706, only one may be taken for credit.
Prerequisite(s): MATH 1225 or MATH 1025 or MATH 1524 or ISC 1105
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3616 - Biological Statistics (3 credits)
Descriptive and inferential statistics in a biological context with real-world examples. In analytical contexts, develops problem-solving skills and ethical reasoning. 3615: Fundamental principles, one- and two-sample parametric inference, simple linear regression, frequency data. 3616: One- and two-way ANOVA, multiple regression, correlation, nonparametrics, using a computer package. STAT 3615 partially duplicates STAT 3005 and STAT 4604, only one may be taken for credit. STAT 3616 partially duplicates STAT 3006, 4604 and 4706, only one may be taken for credit.
Prerequisite(s): STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3654, CS 3654

STAT 3704 - Statistics for Engineering Applications (2 credits)
Introduction to statistical methodology with emphasis on engineering experimentation: probability distributions, estimation, hypothesis testing, regression, and analysis of variance. Only one of the courses 3704, 4604, 4705, and 4714 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (2 Lec, 2 Crd)

STAT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4004 - Methods of Statistical Computing (3 credits)
Computationally intensive computer methods used in statistical analyses. Statistical univariate and multivariate graphics; resampling methods including bootstrap estimation and hypothesis testing and simulations; classification and regression trees; scatterplot smoothing and splines.
Prerequisite(s): STAT 4105 and STAT 4214
Instructional Contact Hours: (4 Lec, 3 Crd)

STAT 4024 - Communication in Statistical Collaborations (3 credits)
Theory and examples of effective communication in the context of statistical collaborations. Practice developing the communication skills necessary to be effective statisticians using peer feedback and self-reflection. Topics include helping scientists answer their research questions, writing about and presenting statistical concepts to a non-statistical audience, and managing an effective statistical collaboration meeting. Senior standing in the Department of Statistics.
Prerequisite(s): STAT 4214 and STAT 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4094 - Introduction to Programming in R (1 credit)
Introduction to R programming techniques with an emphasis on statistical analyses. Topics include: data objects, loops, importing/exporting datasets, graphics, functions, t-tests, ANOVA, linear regression, nonparametric tests, and logistic regression.
Prerequisite(s): STAT 3615 or STAT 3005
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 4105 - Theoretical Statistics (3 credits)
4105: Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics. 4106: Convergence of sequences of random variables; central limit theorem; methods of estimation; hypothesis testing; linear models; analysis of variance. STAT 4105 partially duplicates STAT 4705, STAT 4714, and STAT 4724, only one may be taken for credit.
Prerequisite(s): (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and STAT 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4106 - Theoretical Statistics (3 credits)
4105: Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics. 4106: Convergence of sequences of random variables; central limit theorem; methods of estimation; hypothesis testing; linear models; analysis of variance. STAT 4105 partially duplicates STAT 4705, STAT 4714, and STAT 4724, only one may be taken for credit.
Prerequisite(s): STAT 4105
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4204 - Experimental Designs (3 credits)
Fundamental principles of designing and analyzing experiments with application to problems in various subject matter areas. Discussion of completely randomized, randomized complete block, and Latin square designs, analysis of covariance, split--plot designs, factorial and fractional designs, incomplete block designs.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5605 or STAT 5615 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4214 - Methods of Regression Analysis (3 credits)
Multiple regression including variable selection procedures; detection and effects of multicollinearity; identification and effects of influential observations; residual analysis; use of transformations. Non-linear regression, the use of indicator variables, and logistic regression. Use of SAS.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5606 or STAT 5616 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4274 - Sports Analytics Statistical Research (3 credits)
Statistical analysis of sports data. Game performance statistics and expected scores. Analysis of player performance, player tracking, team performance, and sports betting. Bayesian methods and prediction models applied to sports data. Decision-making. Assessing sports analytics research and literature.
Prerequisite(s): (STAT 4214 and STAT 4444) or (CMDA 4654 or CS 4654 or STAT 4654) or (STAT 3274 or CMDA 3274)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4274

STAT 4364 - Introduction to Statistical Genomics (3 credits)
Statistical methods for bioinformatics and genetic studies, with an emphasis on statistical analysis, assumptions, and problem-solving. Topics include: commonly used statistical methods for gene identification, association mapping and other related problems. Focus on statistical tools for gene expression studies and association studies, multiple comparison procedures, likelihood inference and preparation for advanced study in the areas of bioinformatics and statistical genetics.
Prerequisite(s): (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006) and (STAT 3006 or STAT 3616 or STAT 4706 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4444 - Applied Bayesian Statistics (3 credits)
Introduction to Bayesian methodology with emphasis on applied statistical problems: data displaying, prior distribution elicitation, posterior analysis, models for proportions, means and regression.
Prerequisite(s): (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006) and STAT 3006 or STAT 3616 or STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4504 - Applied Multivariate Analysis (3 credits)
Non-mathematical study of multivariate analysis. Multivariate analogs of univariate test and estimation procedures. Simultaneous inference procedures. Multivariate analysis of variance, repeated measures, inference for dispersion and association parameters, principal components analysis, discriminate analysis, cluster analysis. Use of SAS.
Prerequisite(s): STAT 3006 or STAT 4706 or CMDA 2006 or STAT 3616
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4514 - Introduction to Categorical Data Analysis (3 credits)
Statistical approaches to analyze categorical data. Probability computation and distribution specification, interval estimation and hypothesis testing, formulating and fitting generalized linear models including logistic and Poisson regression, algorithms used for model fitting, variable selection, and classification trees and supervised learning.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4524 - Sample Survey Methods (3 credits)
Statistical methods for the design and analysis of survey sampling. Fundamental survey designs. Methods of randomization specific to various survey designs. Estimation of population means, proportions, totals, variances, and mean squared errors. Design of questionnaires and organization of a survey.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5606 or STAT 5616
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4534 - Applied Statistical Time Series Analysis (3 credits)
Applied course in time series analysis methods. Topics include regression analysis, detecting and address autocorrelation, modeling seasonal or cyclical trends, creating stationary time series, smoothing techniques, forecasting and forecast errors, and fitting autoregressive integrated moving average models.
Prerequisite(s): STAT 3006 or STAT 4104 or STAT 4706 or STAT 4714 or STAT 3616 or BIT 2406 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4584 - Advanced Calculus for Statistics (3 credits)
Introduction to those topics in advanced calculus and linear algebra needed by statistics majors. Infinite sequences and series. Orthogonal matrices, projections, quadratic forms. Extrema of functions of several variables. Multiple integrals, including convolution and nonlinear coordinate changes.
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 1225) and (MATH 1226) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4604 - Statistical Methods for Engineers (3 credits)
Introduction to statistical methodology with emphasis on engineering applications: probability distributions, estimation, hypothesis testing, regression, analysis of variance, quality control. Only one of the courses 4604, 4705, and 4714 may be taken for credit. STAT 4604 partially duplicates STAT 3005, STAT 3615, STAT 3006, STAT 3616 and STAT 4706. Only one may be taken for credit.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4654, CS 4654

STAT 4664 - Computational Intensive Stochastic Modleing (3 credits)
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models.
Prerequisite(s): (STAT 4106 or CMDA 3605) and (CS 1114 or CS 1064 or STAT 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4664

STAT 4705 - Probability and Statistics for Engineers (3 credits)
Basic concepts of probability and statistics with emphasis on engineering applications. 4705: Probability, random variables, sampling distributions, estimation, hypothesis testing, simple linear regression correlation, one-way analysis of variance. 4706: Multiple regression, analysis of variance, factorial and fractional experiments. Only one of the courses 3704, 4604, 4705, 4714, and 4724 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4706 - Probability and Statistics for Engineers (3 credits)
Basic concepts of probability and statistics with emphasis on engineering applications. 4705: Probability, random variables, sampling distributions, estimation, hypothesis testing, simple linear regression correlation, one-way analysis of variance. 4706: Multiple regression, analysis of variance, factorial and fractional experiments. Only one of the courses 3704, 4604, 4705, and 4714 may be taken for credit.
Prerequisite(s): STAT 4705 or STAT 4105 or ISE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4714 - Probability and Statistics for Electrical Engineers (3 credits)
Introduction to the concepts of probability, random variables, estimation, hypothesis testing, regression, and analysis of variance with emphasis on application in electrical engineering. Only one of the courses 3704, 4604, 4705, 4714 and 4724 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4744 - Deep Learning (3 credits)
Introduction to deep learning, including algorithms, theoretical motivations, and implementation in practice. Basic neural network architectures and optimizations. Multilayer perceptrons, backpropagation, automatic differentiation, and stochastic gradient descent. Convolutional neural networks, recurrent neural networks and the attention mechanism. Generative models, variational autoencoders, and generative adversarial networks. Reinforcement learning, Q learning and design of simple AI systems. Python programming language. Emphasis on efficient implementation, optimization, and scalability. Creation of deep learning models in the context of different types of real applications such as image classification and language processing.
Prerequisite(s): (STAT 3104 or CMDA 2006) and (STAT 4214 or CMDA 4654 or STAT 4654 or CS 4654)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4804 - Elementary Econometrics (3 credits)
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations.
Prerequisite(s): AAEC 1005 and (STAT 3615 or STAT 3005 or STAT 3604 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4804

STAT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

STAT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Summer Academy (SUMA)

SUMA 1004 - Summer Academy Placeholder (6 credits)
Instructional Contact Hours: (6 Lec, 6 Crd)

Sustainable Biomaterials (SBIO)

SBIO 1004 - Explorations in Sustainable Biomaterials (1 credit)
Topics and related career paths in Sustainable Biomaterials. Resources promoting academic success, personal improvement, and professional development. Problem solving, inquiry, teamwork, and oral, written, and visual communication applied to sustainable biomaterials issues.
Instructional Contact Hours: (1 Lec, 1 Crd)

SBIO 1014 - Introduction to Packaging Systems and Design (1 credit)
Information and skills necessary to succeed in the Packaging Systems and Design program; use of the library resources and use of intellectual property of others; laboratory reports, presentation skills, safe laboratory practices, and resume and packaging career portfolio.
Instructional Contact Hours: (1 Lec, 1 Crd)

SBIO 1024 - Systems Thinking in a Bioeconomy (3 credits)
Fundamental principles of a systems-thinking approach in evaluating complex systems related to a bioeconomy, which includes continued use and reuse of materials, chemical, and energy derived from natural materials within both industrial and natural environments. Systems mindset and frameworks, methodologies, and tools to contribute to discussions on solving complex problems integrating interconnected social, economic, and environmental factors while considering ethics. Case study-based approach to analyze and assess the impacts of conventional and alternative solutions to real-world challenges.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 1114 - A Sustainable Future through Circular Economy (3 credits)
Concepts, principles, and frameworks to understand sustainable production and consumption systems. Critical exploration of the six "R's": Reduce, Reuse, Repair, Refurbish, Remanufacture, and Recycle. Circular economy models for technical and bio-based materials to enable sustainable design. Special emphasis on systems-thinking methods for evaluating alternative/circular system design for sustainable biomaterials. Elements of sustainable biomaterial products and business models that optimize material efficiency and value-retention. Current initiatives by industry and governments to implement sustainable production and consumption practices and policies around the world.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 1234 - Introduction to Wood, Design and Craftmanship (3 credits)
Wood as a material. Introduction to laboratory techniques, wood processing, machining and woodworking, moisture interactions, species characteristics, microscopic techniques, measuring material properties, characteristics of forest products industry, career opportunities.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2004 - Computer-Aided Design in Packaging (3 credits)
Principles of Computer-Aided Design (CAD) in the packaging industry. Basics of virtual primary package development, computer-aided design of the secondary package, computer-aided optimization of truck loading and palletization. Development of a comprehensive packaging system in a virtual environment.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2104 - Principles of Packaging (3 credits)
History of packaging, structure of packaging industry, careers in packaging, packaging functions, materials and material properties, prototyping and manufacturing methods, packaging forms and types, distribution packaging, printing and decorating, packaging laws and regulations, sustainability issues, packaging design process.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2124 - Structure and Properties of Sustainable Biomaterials (3 credits)
Macroscopic and microscopic structure and chemical composition of wood and other biomaterials such as grasses, bamboo, and bagasse. Relationships between anatomical structure and physical/mechanical behavior. Microscopic identification of commercially important biomaterials. Preparation and analysis of microscope slides and scanning electron micrographs.
Prerequisite(s): BIOL 1105 and CHEM 1035
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2154 - Packaging and Culture (3 credits)
Explore packaging as a fundamental component of human culture. Survey the historical evolution of packaging as material culture and its influence across various domains using fundamental concepts such as cultural diffusion, functionalism, and systems thinking. Topics including the pivotal role of packaging in the transition to agriculture, significance in early legal systems, establishment of weights and measures, contributions to the development of global trade networks, and implications for food security, social institutions, and international conflicts. Identify interconnections in raw material access and cultural factors that influence packaging design, economic systems, trade and world views. Relationship between packaging and human health, equity, and the environment. Historical lessons will be used to analyze contemporary issues and emerging trends to forecast their potential societal impacts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2214 - Design Fundamentals for Packaging (3 credits)
Introduction to the foundation of packaging design, visual elements, design principles, and Adobe Illustrator. Basic studio workshop with focuses on packaging design processes, two-dimensional graphic work, and package design projects. Aesthetic judgment and critical thinking skills through practice in packaging design projects and critique. Design Lab/Studio. Course FEE $46.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 2224 - Materials and Manufacturing Technology: from Nature to Innovation (3 credits)
Properties and characteristics of biomaterials (mechanical, chemical, thermal, etc.) that influence their production, application, value stream, and sustainability. Case-based approach to assessment and evaluation of basic manufacturing processes and the biomaterials used to make products. Perspectives on how manufacturing infrastructures and economies evolved based on the discovery of materials, from pre-industrial biological and nature-based systems to advanced technical materials used today. Manufacturing technology trends and how they are shaping economic, societal, and environmental impacts in biomaterials and related manufacturing technologies and packaging innovation.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2314 - Building Information Modeling for Wood-Based Construction (3 credits)
Building information modeling (BIM), computer-aided design (CAD) and the role of BIM and CAD in wood construction. Use of BIM and CAD to improve construction efficiency. Study of REVIT use including building layout, family editor, detailing, schedules, material lists and 3-dimensional rendering. Discussion of construction documentation and plan reading. BIM methods and tools in the design and detailing of residential light-frame, mass timber, and historic buildings.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2504 - Circular Economy Analytics for Sustainable Systems (3 credits)
Concepts, principles, and framework to understand systems level interactions in linear (cradle-to-grave) and circular (cradle-to-cradle) processes. Problem solving application and practice utilizing computational tools and data analytics. Special emphasis on quantifying and evaluating life-cycle circularity of common products and processes used to meet societys demand. Evaluation of case study results towards the planning of more circular business models in a complex global economy. Risks and ethical issues associated with decision making and policy based on results from computational models. Pre: Precalculus with Transcendental Functions (3 credits)
Prerequisite(s): MATH 1014 or MATH 1025 or MATH 1225 or MATH 1524 or MATH 1535 or MATH 1525
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2514 - Introduction to Sustainability and Industrial Ecology (3 credits)
Explore fundamental sustainability concepts and industrial ecology principles, navigate the intricate interactions between natural and industrial environments. Discover how nature-based design and innovation inform industrial practices in food, water, transportation, and energy systems and contribute to more sustainable futures. Apply methodologies like Material Flow Analysis, Life Cycle Analysis, and handprint analysis to create decision-making tools for broadening positive impacts. Use data collection, analytics, and accounting techniques to assess conventional and nature-based industrial system performance. Develop innovative solutions to real-world sustainable challenges such as climate resilience, sustained food production, and improved well-being.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2614 - Introduction to Forest Products Marketing (3 credits)
Study of marketing systems and methods used by North American primary and secondary forest product industries. Emphasis on wood product industries. Marketing of hardwood lumber, softwood lumber, panels, composites, furniture, and paper products. Role of North American industries and markets in world trade of forest products.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2784 - Global Forest Sustainability (3 credits)
A socio-economic approach to examining the management and use of the worlds forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2784

SBIO 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3004 - Sustainable Nature-Based Enterprises (3 credits)
Planning for green and sustainability values for profit and non-profit enterprises that produce and market nature-based products and services (e.g., wood products, wildlife, fish, ecotourism). Understanding current green business environments to foster natural resource-based enterprises.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3005 - Sustainable Packaging Design and Innovation (3 credits)
3005: Principles of sustainability, laboratory packaging evaluation including testing procedures, simulation of physical hazards. Professional communications including laboratory reports and oral presentations. Development of comprehensive packaging evaluation plans. Evaluation of existing packaging systems and improving them from the sustainability perspective. 3006: Application of project management to the packing development process. Apply lean management principles to packing design process. Design of sustainable packaging solutions through industry sponsored projects.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3006 - Sustainable Packaging Design and Innovation (3 credits)
3005: Principles of sustainability, laboratory packaging evaluation including testing procedures, simulation of physical hazards. Professional communications including laboratory reports and oral presentations. Development of comprehensive packaging evaluation plans. Evaluation of existing packaging systems and improving them from the sustainability perspective. 3006: Application of project management to the packing development process. Apply lean management principles to packing design process. Design of sustainable packaging solutions through industry sponsored projects.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3014 - Life Cycle Assessment Field Course (1 credit)
Cultivate hands-on experience in defining the scope and system boundaries of life cycle assessment (LCA) to collect data for computational LCA work. Apply the step-by-step LCA methodology to real-world problems to develop a streamlined LCA impact assessment and interpret the results in simple language for discussions with stakeholders. Use feedback from stakeholder discussions to discover how to improve the LCA assessment process. Each class will concentrate on specific types of LCA applications, namely Social LCA, Economic LCA (e.g., Life Cycle Costing), or Environmental LCA (e.g., water or carbon footprinting). Students will have an opportunity to apply their LCA work across selected sectors such as manufacturing, transportation, agricultural and/or forestry, and energy. This course may be repeated two times with different content for a maximum of 3 credit hours.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

SBIO 3104 - Packaging Design Applications (3 credits)
Design structure of packaging with Adobe Photoshop, Adobe Illustrator, and Esko. Lab course adapting typography, illustration, and photography to create packaging prototypes. Structural integrity and display ethics through practice in packaging design projects and research. Identify the product target market. Design/Lab Studio. Course FEE $78.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 3124 - Paper and Paperboard Packaging (3 credits)
Paper and paperboard properties and types. Types and performance of flexible paper packaging, sacks, and wraps. Folding carton design, properties of corrugated fiberboard. Corrugated fiberboard container design and performance. Packaging regulations and hazards of the distribution environment. Printing, labeling and automatic identification methods.
Prerequisite(s): SBIO 2104
Corequisite(s): SBIO 2004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3224 - Packaging Distribution Systems (3 credits)
Unit load and parcel supply chains. Principles of operation and design of warehouse distribution and fulfillment centers. Principles of operation and design of shipping and distribution systems. The relation between packaging design, pallet design, and unit load design and the operation of industrial consumer goods supply chain.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3244 - Packaging Machinery and Production Systems (3 credits)
Selection of machinery systems to form, fill and seal packaging operations for multiple package and material categories; analysis of the effect of packaging design and material selection on production efficiency and manufacturing capacity; statistical process control for packaging systems; packaging line design.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3264 - Packaging Supply Chain (3 credits)
Supply chain strategies for packaging. Principles for planning and control of inventory, emphasis on dependent demand and material requirement planning for packaging materials in consumer-packaged goods companies; analysis and management of packaging components procurement, and supply contracts in a globalized environment; financial aspects of logistics and supply chain operations; logistics for returnable packaging containers.
Prerequisite(s): SBIO 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3284 - Packaging Polymers and Production (3 credits)
Introduction to synthetic, natural and sustainable polymer science and engineering as applied to packaging systems. Morphology, rheology, physical and thermal properties, processing methods, and polymerization of traditional, natural and sustainable packaging polymers. Detailed study of relationships among materials, processing, and structural properties through hands-on experience. Both traditional and advanced industrial mass production technology, and global regulation and environmental impact of packaging articles.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 3314 - Mechanics of Sustainable Biomaterials and Packaging (4 credits)
Mechanical properties of sustainable biomaterials and packaging materials including concepts of stress, strain, Poissons ratio, orthotropic properties, tension, compression, bending and effects of moisture on mechanical properties. Current issues related to sustainable biomaterial and packaging material use in industry. Standard methods of evaluating important mechanical properties of solid wood, composites, packaging, paperboard and fiber.
Prerequisite(s): PHYS 2205 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SBIO 3324 - Green Building Systems (3 credits)
Definition of green buildings with specific focus on wood frame single family housing and appropriate green building systems. Site specification, resource efficiency, water efficiency, indoor environmental quality, homeowner education and global impact. Certification in various green building systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3334 - Survey of Non-timber Forest Products (3 credits)
In depth study of non-timber forest products of NTFP throughout Appalachia with overseas example - their heritage, uses and markets, economic development opportunities, and sustainable management. Emphasis will be placed on utilization and management issues. Students will gain skills necessary to assess and plan for NTFP business opportunities.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3434 - Chemistry and Conversion of Sustainable Biomaterials (3 credits)
Chemical composition of plant matter. Chemistry and biosynthesis of plant components. Cellulosic biofuel technology. Industrial conversion of woody biomass: pulping, bleaching, papermaking. Industrial conversion of cellulose by chemical processes.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3444 - Sustainable Biomaterials and Bioenergy (3 credits)
Introduction to the structure and properties of natural composites, biobased polymers, and naturally-derived chemicals for materials and energy applications. Chemistry of biomass deconstruction. Industrial applications of biobased polymers, monomers, and chemicals.
Prerequisite(s): (CHEM 2514 or CHEM 2535) and (CHEM 3615 or CHEM 4615)
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3445 - Entrepreneurial Wood Design and Innovation (3 credits)
Concept to market business project applied to design and innovation of wood products. Product design based on consumer need and sustainable use of natural resources. Writing a business plan including, product innovation, resource sustainability, marketing, strategic planning, production planning, technology utilized, packaging and distribution to final market.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3446 - Entrepreneurial Wood Design and Innovation (3 credits)
Students run teams and experiential learning to organize and deploy the project according to a business plan, measure key performance areas, and manage the quality of the product and process value streams necessary to sustain a profitable business.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3454 - Society, Sustainability Biomaterials and Energy (3 credits)
Sustainability, raw materials and energy needs of society. Use of sustainable biomaterials to meet societys needs and reduce impact on the environment. Methods to evaluate and certify the sustainability of materials and consumer goods. Carbon sequestration and the use biomass for energy.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3464 - Sustainable Operations Management (3 credits)
Sustainable business management models of renewable-based materials organizations. Application of strategy deployment tools to sustainable bio business strategies. Analysis of financial statements of bio businesses using ratio analysis. Implementation of models and tools to analyze production systems based on cycle time, throughput, and inventory (factory dynamics). Simulation and optimization of manufacturing systems using probability function models. Statistical quality control charts for discrete and continuous variables.
Prerequisite(s): STAT 2004 or STAT 3615 or STAT 3005 or STAT 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3524 - Manufacture of Sustainable Biomaterials for Structures (3 credits)
Principles of manufacturing sustainable biomaterials into primary and secondary products used in construction of buildings, houses and other structures; product demand and environmental impact; raw material quality and volume estimation; industry standards; manufacturing processes; and quality control methods.
Prerequisite(s): SBIO 2124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3554 - Sustainable Biomaterials Enterprises (3 credits)
Processes and techniques in manufacturing sustainable biomaterial-based products. Contemporary manufacturing, industrial engineering, and business practices in enterprises. Problem solving, operations management, and effective leadership in discrete products manufacturing and sustainable biomaterials production practices.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

SBIO 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4004 - Senior Seminar in Forest Products Business (2 credits)
Integrated application of principles of management, manufacturing, and marketing as applied to wood-based and related industries. Case analysis, business planning and strategic decision making. Senior standing required.
Prerequisite(s): SBIO 3634
Instructional Contact Hours: (2 Lec, 2 Crd)

SBIO 4024 - Packaging Design for Global Distribution (3 credits)
Understanding, identification, and measurement of hazards in physical distribution including sea, air, and various land transportation, storage methods, and use of sanitation methods. Knowledge, analysis, and selection of sustainable protective packaging materials. Design and analysis of packaging protection against such hazards as shock, vibration compression, and climate. Laboratory testing of shock, vibration and compression, and performance testing of packaging and components. Packaging design in global context.
Prerequisite(s): SBIO 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4054 - Packaging Systems Design Practicum (3 credits)
Integrated application of principles of packaging design and manufacturing. Design briefs, package development process, structural requirements, manufacturing and distribution plans, target markets and positioning. Senior Standing required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4154 - Computer Application Systems in Forest Products (3 credits)
Computer control systems with applications in the forest products industry. Survey of systems for gathering, inputting, conditioning, and managing information. Hardware and software systems for computer control applications. Use of information technologies to integrate control subject to raw material, quality, and market fluctuations. Forest products case studies in data acquisition, data analysis, database management production planning, process control, inventory control, and systems specification. Junior standing is required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4164 - Sustainability Performance and Assessments (3 credits)
Data analytics, metrics, and tools essential for navigating sustainability standards, current policies, regulations, and reporting requirements, and their applications in sustainable investment. Explore innovations in sustainable investment strategies, emphasizing the integration of sustainability concepts and industrial ecology principles into business frameworks. Case studies approach to illustrate both successful and unsuccessful sustainability strategies across diverse contexts, such as energy sector, manufacturing, among other, providing insights into practical applications and outcomes.
Prerequisite(s): SBIO 2514
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4214 - Food and Health Care Packaging (3 credits)
Designed for both current and advanced food and health care packaging. Covering the types of materials and their properties, fabrication, functions, distribution and packaging life cycle for food and health care packaging systems and design. Reviewing recent trends in food and health care packaging systems; sustainable food packaging, medical device packaging, aseptic packaging, package/product interactions, smart active packaging, handling of packages, and modified atmospheric packaging. Exploration to global food and health care packaging standards and compliance, safety issues, and environmental considerations.
Prerequisite(s): SBIO 3124 and SBIO 3284
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 4224 - Industrial Packaging Systems (3 credits)
Principles of pallet design including material selection, pallet repair methods and recycling, properties and selection of pallet fasteners. Principles of industrial packaging systems including handheld containers, bulk bins, drums, pails, bags, intermediate bulk containers, flexible intermediate bulk containers. Principles of unit load design including unit load interactions and application of load stabilizers. Principles of reusable packaging systems, shipping laws and regulations.
Prerequisite(s): SBIO 4024 and SBIO 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4254 - Advanced Manufacturing with Sustainable Biomaterials (3 credits)
Modeling and visualization concepts in computer-aided design (CAD) that facilitate advanced manufacturing technologies. Advanced manufacturing tools such as computer-aided manufacturing (CAM) and computer-aided engineering (CAE) used to study the function, cost, and quality that may result from modeled product concepts. Interactions of model specifications and the materials and manufacturing methods utilized on production results. Data analytics to evaluate tradeoffs in the quality, cost, and sustainability of products utilizing sustainable biomaterials compared to other common materials utilized in manufacturing.
Prerequisite(s): SBIO 2004 and SBIO 3314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4314 - Design of Wood Structures (3 credits)
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls.
Prerequisite(s): SBIO 3314 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 4314

SBIO 4384 - Biorefinery Science (3 credits)
Biomass utilization as an industrial resource. Biorefinery processes such as cultivation, harvesting, separation, and biomass processing into industrial products compared to the petroleum refinery. Routes to the production of bioenergy, biochemicals, and biofuels. Resource availability and energy consumption, environmental implications of a biorefinery system, public policy influence on development of biorefineries.
Prerequisite(s): SBIO 3434
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4424 - Polysaccharide Chemistry (3 credits)
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 4424

SBIO 4444 - Plant Polymers & Biocomposites (3 credits)
Evolution of vascular plants and plant polymers in the context of materials science and biocomposites. Anatomical, physical, and mechanical properties of wood, bamboo, and hemp. Polymer science, plant polymer science, surface chemistry, and adhesion science for biocomposites made from wood, bamboo, and hemp. Contemporary adhesives and resins for biocomposites manufacture.
Prerequisite(s): CHEM 2514 or CHEM 2536
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4514 - Wood Products Industry Studies (1 credit)
Field studies of the processing systems and product manufacturing procedures of various wood products industries.
Prerequisite(s): SBIO 3114
Instructional Contact Hours: (3 Lab, 1 Crd)

SBIO 4624 - Wood Industry Production Operations Management (3 credits)
Study of the operation of wood products organizations. Problems facing these organizations and current management practices used to address these problems. Investigation of the design and implementation of wood industry management improvement efforts. How organizations and groups design, implement, and evaluate improvements efforts. The application of techniques to production planning, financial management, inventory management, quality, human resources management, technology, performance measures, and assessment. Includes case studies of wood products manufacturing companies.
Prerequisite(s): SBIO 3544
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4634 - Forest Products Business Management (3 credits)
This course will describe the allocation of resources within a forest products business. Students will determine how to allocate natural, human and financial resources to maximize profitability within the organization. How allocation decisions affect all stakeholders of the organization will be demonstrated and this allocations impact upon strategic planning will be discussed. The course will also show the impact of the external business environment on management decisions.
Prerequisite(s): SBIO 1234 and SBIO 2614 and SBIO 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4714 - Performance of Sustainable Biomaterials in Buildings (3 credits)
The use of manufactured sustainable biomaterials in the construction of buildings; interactions of building code requirements, sustainable biomaterials and bio-composite materials as components within houses; durability, deterioration, controlling moisture infiltration, preservatives and proper selection of materials, historic wood buildings, effectiveness and efficiency of sustainable biomaterial building systems; serviceability issues in buildings with sustainable biomaterials.
Prerequisite(s): SBIO 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Systems Biology (SYSB)

SYSB 2024 - Fundamentals of Systems Biology (3 credits)
Introduction to fundamental concepts of systems biology: biological systems, molecular regulatory networks, modeling approaches in systems biology with case studies, high-throughput data generation and bioinformatics data processing.
Prerequisite(s): MATH 1225 and (BIOL 1105 or ISC 1106H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106H)
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 2034 - Mathematical Methods in Systems Biology (3 credits)
Fundamental mathematical methods in systems biology, including differential equations, graph theory, Boolean mathematics, and concepts of probability. Applications of these methods to developing models of biological regulatory networks and dynamical systems. Software tools for Systems Biology.
Prerequisite(s): SYSB 2024 and MATH 1226 and (CS 1064 or CS 1114)
Corequisite(s): MATH 2114, MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 3035 - Genomics and Bioinformatics (4 credits)
Bioinformatic approaches in omics, namely genomics and transcriptomics. 3035: Genomic architecture and evolution. Gene expression and post-translational regulation. Structure and function of genes and other genetic elements. Experimental techniques for generating genomic and transcriptomic data. 3036: Statistical, evolutionary, and computational models and methods to analyze omics data. Techniques for visualization and biological interpretation of omics data derived from experiments. Application of Python and R to bioinformatics. Case studies and specific applications in molecular biology, including comparative genomics, cancer, and infectious diseases.
Prerequisite(s): BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3036 - Genomics and Bioinformatics (4 credits)
Bioinformatic approaches in omics, namely genomics and transcriptomics. 3035: Genomic architecture and evolution. Gene expression and post-translational regulation. Structure and function of genes and other genetic elements. Experimental techniques for generating genomic and transcriptomic data. 3036: Statistical, evolutionary, and computational models and methods to analyze omics data. Techniques for visualization and biological interpretation of omics data derived from experiments. Application of Python and R to bioinformatics. Case studies and specific applications in molecular biology, including comparative genomics, cancer, and infectious diseases.
Prerequisite(s): SYSB 3035
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3115 - Network Dynamics and Cell Physiology (4 credits)
In-depth study of how molecular regulatory networks determine the physiological properties of prokaryotic and eukaryotic cells. 3115: Biochemical reaction networks, nonlinear dynamical systems, parameter estimation, bifurcation theory, switches and oscillators, gene regulatory networks, signaling pathways, metabolic networks, neural networks, applications. 3116: Stochastic effects, cell cycle and cancer, spatial effects, motility, development, tissue dynamics, applications.
Prerequisite(s): SYSB 2034
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3116 - Network Dynamics and Cell Physiology (4 credits)
In-depth study of how molecular regulatory networks determine the physiological properties of prokaryotic and eukaryotic cells. 3115: Biochemical reaction networks, nonlinear dynamical systems, parameter estimation, bifurcation theory, switches and oscillators, gene regulatory networks, signaling pathways, metabolic networks, neural networks, applications. 3116: Stochastic effects, cell cycle and cancer, spatial effects, motility, development, tissue dynamics, applications.
Prerequisite(s): SYSB 3115
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 4024 - Careers and Professionalism in Systems Biology (2 credits)
Career planning, interviewing skills, and training in written and oral communication in systems biology. Critical evaluation of research, effective communication of scientific results, ethical standards in science, societal trends.
Prerequisite(s): SYSB 3036 and SYSB 3116
Corequisite(s): SYSB 4065
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4065 - Research Experience in Systems Biology (2 credits)
Training and practical experience in the conduct of systems biology research. 4065: Plan a research project, develop a research hypothesis, and perform preliminary testing and analysis. 4066: Execute, refine, complete, and document the projects results.
Prerequisite(s): SYSB 3036 and SYSB 3116
Corequisite(s): SYSB 4135
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4066 - Research Experience in Systems Biology (2 credits)
Training and practical experience in the conduct of systems biology research. 4065: Plan a research project, develop a research hypothesis, and perform preliminary testing and analysis. 4066: Execute, refine, complete, and document the projects results.
Prerequisite(s): SYSB 4065
Corequisite(s): SYSB 4136
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4114 - Applied Models of Gene Regulatory Networks (3 credits)
Dynamic modeling of gene regulatory networks. Gene regulatory networks with oscillatory and switch-like dynamic behavior. Design of synthetic genetic switches and oscillators. Modeling gene regulation controlling cell fate, cell differentiation, cell-to-cell communication, synchronization and developmental processes. Real-world research problems and applications.
Prerequisite(s): SYSB 2034 and SYSB 3116
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 4224 - Big Data Analysis Methods in Systems Biology (3 credits)
Big data analysis in systems biology. Emphasis on data storage/retrieval and curation, statistical modeling of gene expression, enrichment analysis, clustering, parameter optimization and estimation in systems biology models, linear and nonlinear classification methods.
Prerequisite(s): (SYSB 2034 or MATH 1226) and (STAT 3005 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Technology Education (EDTE)

EDTE 1004 - Introduction to Integrative STEM Education (3 credits)
Introduction to creative hands-on problem-solving using technological and engineering design and application. Comprehensive views of how technology and engineering require integration of knowledge to solve technological challenges. Intersection of science, technology, engineering, and mathematics (STEM) with society. Use of virtual and hands-on modeling to identify, evaluate, and test the proper materials and processes for product design. Professional skills such as problem-solving, collaboration, and effective communication.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 1014 - Teaching Technology, Engineering, and Design (3 credits)
Introduction to strategies for teaching technology, engineering, and design in middle and high schools. Exploration of state standards and national recommendations for teaching technology, engineering, and design. Curriculum design and pedagogical frameworks for teaching technological and engineering design-based learning activities, implementing differentiated instruction, and addressing industry trends.
Prerequisite(s): EDTE 1004 or ENGE 1215 or ENGE 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2005 - Engineering Technologies (3 credits)
Fundamentals of technology and engineering design for middle and high school technology educators. 2005: Human needs and cultural context in engineering design process and design thinking. Contributions of systems engineering. Knowledge and skills for processing common materials. Introduction to computer-aided design for two and three-dimensional modeling. Laboratory safety. 2006: Technology and engineering practices. Measurement, analysis, and simulation tools and techniques. Advanced materials processing. Application of computer-aided design for two and three-dimensional modeling. Teaching technology in 6th through 12th grade classrooms.
Prerequisite(s): EDTE 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2006 - Engineering Technologies (3 credits)
Fundamentals of technology and engineering design for middle and high school technology educators. 2005: Human needs and cultural context in engineering design process and design thinking. Contributions of systems engineering. Knowledge and skills for processing common materials. Introduction to computer-aided design for two and three-dimensional modeling. Laboratory safety. 2006: Technology and engineering practices. Measurement, analysis, and simulation tools and techniques. Advanced materials processing. Application of computer-aided design for two and three-dimensional modeling. Teaching technology in 6th through 12th grade classrooms.
Prerequisite(s): EDTE 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2204 - Emerging Issues in Technology and Engineering (3 credits)
Examination of current and projected technology and engineering topics that are growing in regional, state, national, and global importance. Analyzing how the Grand Challenges for Engineering shape future technological advancements and their impact on societies, the environment, and global issues. Development, revision, and field-testing of appropriate learning activities for middle and high school students in selected topic areas.
Prerequisite(s): EDTE 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 3204 - Robotics Education (3 credits)
Introduction to designing robotic systems including sensors, electronic components, and mechanical devices. Foundational technical developments in the use of robots and other computer-controlled devices including technical reporting. History and evolution of robots and automation and their social, economic, industrial, and educational impacts. Robotics-based instruction for middle and high-school students.
Prerequisite(s): EDTE 2006 and CS 1014 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 3964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4204 - Capstone in Technology and Engineering Education (3 credits)
Workforce experience in technology and engineering education, including open-ended research, design, and industry collaboration. Open-ended and team-focused challenges in STEM contexts. Design-cycle (from problem identification to prototype and technical reporting) based on global, economic, environmental, and societal challenges. Comprehensive instructional unit planning to prepare pre-service educators to teach technological and engineering design-based learning to middle and high school students.
Prerequisite(s): EDTE 2204 and EDTE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)
Course Crosslist: ALS 4754

EDTE 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Theatre and Cinema (TA)

TA 1004 - School of Performing Arts First Year Experience (1 credit)
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the Schools programs. Foster a sense of community and understanding across disciplines.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: MUS 1004

TA 2014 - Introduction to Theatre (3 credits)
Appreciation and understanding of theatre as a living, collaborative art form through historical and intercultural perspectives, readings of key texts and analysis of scripts, and explorations of all elements of the theater making process, including playwriting, directing, acting, and design.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2024 - Introduction to Acting (3 credits)
Introductory performance class in acting skills and theories as a participant (actor) and observer (audience) for the non-major. Includes performances of dramatic literature/ improvisation for live audience, creating character biography and script analysis, historical and intercultural contexts, and techniques in constructive criticism that incorporate interpretive strategies.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2044 - Contemporary African American Theatre (3 credits)
Contributions of U.S. Black theatre artists; intersectional identities; performances spaces and society; critical race theory; dramatic storytelling; cultural behaviors; racial discrimination.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2044, ENGL 2044

TA 2104 - Fundamentals of Theatre and Production (3 credits)
Introduction to theatre vocabulary and understanding of the theatrical process, theatre aesthetics, theatrical modes of expression, basic script analysis, production analysis, theory and practice of collaboration, theatre organizations, history and operations of professional theatres. (T & C majors and minors only).
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2114 - Script Analysis (3 credits)
Understanding of drama as an element of theatre with focus on the process of script analysis for theatrical production.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2134 - Acting Lab (3 credits)
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on improvisation, terminology, physical action, script analysis, characterization, and rehearsal and performance techniques. Limited to Theatre & Cinema Majors.
Instructional Contact Hours: (6 Lab, 3 Crd)

TA 2144 - Foundations of Movement and Voice (3 credits)
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on various methods of performance style and analysis, theater movement and body conditioning, and vocal awareness and production. Limited to Theatre & Cinema Majors.
Prerequisite(s): TA 2134
Instructional Contact Hours: (6 Lab, 3 Crd)

TA 2164 - Scene Design Lab (3 credits)
An introduction to the processes, technologies, and aesthetics of scene design for theatrical productions and analysis of playscripts. Students develop workshop drawing, conceptual design and vision, and collaborative skills related to scene design, and exploration is focused in historical and contemporary theatre practice. A range of design problems will offer opportunity to learn various design approaches and provide practice with different media and means of design expression. Design Lab.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

TA 2174 - Costume Design Lab (3 credits)
Introduction to the processes, technologies, and aesthetics of costume design for theatrical productions and analysis of playscripts. Focus on developing workshop drawings, conceptual design and vision, and collaborative skills related to costume design, with special emphasis on historical and contemporary theatre practice. Various design approaches, different media, and a range of design problems are introduced. Design Lab/Studio.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

TA 2204 - Creative Dance (3 credits)
Study of the expressive elements of movement and dance. Basic choreographic procedures and small group work to design dances that emphasize particular movement concepts. Experience in music and movement of diverse dance cultures. Documentation of the pathways of dances in floorplans and written reflections on the creative processes.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2224 - Intermediate Performance Intensive (3 credits)
This course provides the Theatre & Cinema major, who desires a rigorous exploration of acting, a forum for application of the techniques and skills learned. These skills will be strengthened and applied through observation of and participation in scene and monologue work. Focus will be placed on basic skills and concepts necessary to creative, truthful, and believable performance of selected scenes, including use of voice and body, imagination, relaxation, sense and emotion memory, and script analysis. Limited to Theatre & Cinema Majors.
Prerequisite(s): TA 2134 and TA 2144
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2404 - Introduction to Applied Collaborative Techniques (3 credits)
Introduction to principles of collaboration in applied theatre for non-majors. Situational awareness, intrapersonal and interpersonal awareness, audience engagement, effective storytelling, team creativity and conflict resolution, and communicating across difference in public and professional settings.
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2414 - Stage and Lighting Technology (3 credits)
A practical study of the technologies and specialized equipment employed in the construction, rigging and running of theatrical production; the planning and organization involved in mounting these productions; the tools, materials and techniques used to realize theatrical design and build scenery; and the fundamentals of stage lighting.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2604 - Introduction to Arts Marketing (3 credits)
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field, and direct hands-on experience.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MUS 2604

TA 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

TA 2984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 3014 - Theatre Production Lab (1-3 credits)
Production experiences in the areas of performance, design and theatre technology, management, and writing. May be repeated for a maximum of nine credits.
Instructional Contact Hours: (1-3 Lab, 1-3 Crd)
Repeatability: up to 9 credit hours

TA 3024 - Intermediate Acting for Non-Theatre Major (3 credits)
Performance class in acting skills, theories, and genres. Designed for non-theatre arts majors. Builds on fundamentals and theory learned in Introduction to Acting. Includes body and voice awareness, performance of specific genres, and expanded acting theory and analysis.
Prerequisite(s): TA 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3104 - Sound Technology Topics (3-6 credits)
Rotating topics in theatre sound technology and sound design. Designed for advanced theatre arts and cinema majors who have foundational training in areas of theatre technology and design. May be repeated 2 times with different content for a maximum of 9 credit hours. Design Lab.
Prerequisite(s): TA 2414
Instructional Contact Hours: (1 Lec, 3-8 Lab, 3-6 Crd)
Repeatability: up to 9 credit hours

TA 3105 - History of Drama and Theatre (3 credits)
History of drama and theatre from primitive ritual to the present day and its relationship to the social, economic, and political forces from age to age. 3105: primitive, Greek, Roman, Medieval, Renaissance, and Asian. 3106: Restoration, eighteenth, nineteenth, and twentieth centuries. Junior standing required.
Prerequisite(s): TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3106 - History of Drama and Theatre (3 credits)
History of drama and theatre from primitive ritual to the present day and its relationship to the social, economic, and political forces from age to age. 3105: primitive, Greek, Roman, Medieval, Renaissance, and Asian. 3106: Restoration, eighteenth, nineteenth, and twentieth centuries.
Prerequisite(s): TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3114 - Scenography Topics (9 credits)
Rotating topics in scenography and related specific design applications. Designed for theatre arts majors who have foundational training in areas of theatre design. May be repeated for credit.
Prerequisite(s): TA 2164
Instructional Contact Hours: (9 Lec, 9 Lab, 9 Crd)
Repeatability: up to 9 credit hours

TA 3124 - Costume Design and Technology Topics (1-9 credits)
Rotating topics of costume design and costume technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre design. May be repeated for credit.
Prerequisite(s): TA 2174
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

TA 3134 - Lighting Topics (1-9 credits)
Rotating topics in lighting design and technology. Designed for advanced theatre arts majors who have foundational training in all areas of theatre arts. May be repeated for credit. (Variable credit)
Prerequisite(s): TA 2414
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

TA 3144 - Theatre Technology Topics (9 credits)
Rotating topics in design and theatre technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre technology and design. May be repeated for unlimited number of credit hours.
Prerequisite(s): TA 2414
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3154 - Acting Topics (9 credits)
Rotating topics in performance skills and theories. Designed For advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit.
Prerequisite(s): TA 2224 and TA 2144
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3164 - Voice and Speech Topics (9 credits)
Rotating topics in voice and speech skills, and theories and practice in performance. Designed for advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit.
Prerequisite(s): TA 2224 and TA 2144
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3174 - Movement Topics (9 credits)
Rotating topics in theatre movement, dance for the theatre and theories of physical expression in the performing arts. Designed for advanced theatre arts majors who have foundational training in acting voice and movement. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): TA 2144 and TA 2224
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3315 - Playwriting (3 credits)
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3315

TA 3604 - Arts Management (3 credits)
The development of the not-for-profit arts organization, structures and characteristics of boards of directors, artistic missions and goals, funding, volunteer support, and fiscal control. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3624 - Stage Management (3 credits)
The systems, procedures, forms, and duties of the stage manager in the professional, academic, and community theatre are explored in relationship to the production process and other theatre artists.
Prerequisite(s): TA 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 3954F - Study Abroad (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

TA 3954M - Study Abroad (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 3984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 4014 - Contemporary Theatre Seminar (3 credits)
Issues and concerns in contemporary theatre; production philosophies and approaches, employment opportunities, career options, and preparation of portfolio and resume materials. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4304 - Theatre Outreach (1-3 credits)
Participation in theatre projects or activities that focus on community and social issues. May be repeated for a maximum of six credits. Junior standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

TA 4315 - Directing (3 credits)
Script analysis, theories, techniques, and practical applications of theatrical direction. 4315: Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. 4316: Rehearsal techniques, style determination realism, and non-realism. Senior standing required.
Prerequisite(s): TA 2134 and TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4316 - Directing (3 credits)
Script analysis, theories, techniques, and practical applications of theatrical direction. 4315: Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. 4316: Rehearsal techniques, style determination realism, and non-realism.
Prerequisite(s): TA 4315
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4704 - Professional Theatre Internship (9-15 credits)
Internship of one semester in acting, directing, management, design, or technical theatre or cinema with a professional equity company for selected advanced students; classroom, workshop, and production experiences. Minimum 9 credits, maximum 15 credits. Audition and consent.
Instructional Contact Hours: (9-15 Lec, 9-15 Crd)
Repeatability: up to 15 credit hours

TA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Trans Biol Medicine & Health (TBMH)

TBMH 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

TBMH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TBMH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

University Course Series (UNIV)

UNIV 1004 - College Success Strategies (3 credits)
Study and application of strategies, skills, attitudes and behaviors leading to effective academic learning in a college setting. Credit not applicable to meeting degree requirements; may not be repeated.
Instructional Contact Hours: (3 Lec, 3 Crd)

UNIV 1824 - Pathways to Success: Exploring Your Future (3 credits)
Introductory experience course for University Studies and Explore Technology majors. Create fundamental knowledge and develop skills that facilitate successful transition to the university and develop decision-making skills, problem solving, inquiry, research majors and careers, critical thinking and integration of knowledge. Examine their personal decision towards their major utilizing psychosocial and identity in support of a successful transition. Evaluate sources of information to make an argument.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UNIV 1984 - Special Study (1-19 credits)
May not count towards degree requirements; consult advisor.
Instructional Contact Hours: Variable credit course

UNIV 2114 - Unleash Your HokiePotential (1 credit)
First-Year Experience course for transfer students. Establish fundamental knowledge and develop skills that facilitate a successful transition into Virginia Tech. Develop/refine decision-making skills, problem-solving skills, critical thinking, and inquiry. Examine personal strengths, values, goals, and integration of knowledge; establish academic, personal, and career goals in support of a successful transition to Virginia Tech. Topics covered will include: principles of community, academic integrity, campus resources, digital and informational literacy, career planning, academic planning, and goal setting.
Instructional Contact Hours: (1 Lec, 1 Crd)

UNIV 2394 - Introduction to Residential Communities and Leadership (3 credits)
This course provides theories, basic principles, and skill development that serve as a knowledge base and framework for the peer helping, para-professional Resident Advisor position. This course is open only to students who are serving in their first semester as a Resident Advisor.
Instructional Contact Hours: (3 Lec, 3 Crd)

UNIV 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UNIV 3944 - VT Study Abroad Enrollment (0 credits)
Participation in an approved study abroad program without direct supervision of the VA Tech faculty but with required enrollment in an approved program of study in an international university. Course represents 12 billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

UNIV 3944S - VT Study Abroad Enrollment 3 (0 credits)
Participation in an approved study abroad program without direct supervision of the VA Tech faculty but with required enrollment in an approved program of study in an international university. Course represents three billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

UNIV 3944T - VT Study Abroad Enrollment 4 (0 credits)
Participation in an approved study abroad program without direct supervision of the VA Tech faculty but with required enrollment in an approved program of study in an international university. Course represents four billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

UNIV 3944U - VT Study Abroad Enrollment 6 (0 credits)
Participation in an approved study abroad program without direct supervision of the VA Tech faculty but with required enrollment in an approved program of study in an international university. Course represents six billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

UNIV 3944V - VT Study Abroad Enrollment 7 (0 credits)
Participation in an approved study abroad program without direct supervision of the VA Tech faculty but with required enrollment in an approved program of study in an international university. Course represents four billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

UNIV 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

UNIV 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

University Honors Program (UH)

UH 1404 - Principles of Collaborative Discovery (3 credits)
Introduction to honors education at Virginia Tech. Disciplinarity, interdisciplinarity, multidisciplinarity, and transdisciplinarity. Qualitative and quantitative research methods. "Wicked problems," systems thinking, and collaborative discovery. Problem analysis and iterative thinking. Ethical dimensions of trans-sector activity.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 1504 - PGS PStudy Abroad Pre-Departure Seminar (2 credits)
Orientation for Presidential Global Scholars (PGS) participants. Introduction to theories of culture and cross-cultural competence. Survey of Swiss culture, history, and politics. Introduction to PGS faculty and research interests. Development of individual research questions; transdisciplinary research on critical issues in U.S. contexts. Critical travel and safety information.
Instructional Contact Hours: (2 Lec, 2 Crd)

UH 1604 - Introduction to Honors Quantitative and Qualitative Research Practices (3 credits)
Introduction to critical practices in undergraduate quantitative and qualitative research for Honors College students, including generating focused research questions, finding scholarly literature, organizing data, conducting ethical research, collaborative research practices, and identifying venues to present research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 2124 - Honors Reading Seminar (1 credit)
Reading based sections in which small groups of students practice discussion, debate, and argumentation grounded in a topic or genre of reading of their groups choosing. Honors standing. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2504 - Topics in Discourse and Global Citizenship (3 credits)
Discovery, analysis, creation, and evaluation of written, spoken, and visual presentation of ideas in cross-cultural contexts. Special attention to the relationship of rhetoric to effective participation in academic, professional, and public/civic problem-solving. Course cannot be repeated for credit.
Corequisite(s): UH 2524, UH 2534, UH 2544, UH 2554, UH 4994
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2514 - Topics in Quantitative/Computational Thinking and Global Citizenship (3 credits)
Application of quantitative/computational thinking in cross-cultural civic/public contexts. Use of quantitative/computational thinking to frame a question and devise a solution related to a civic/public issue. Drawing valid quantitative inferences about civic/public and cross-cultural issues characterized by inherent uncertainty. Evaluating conclusions or decisions about civic/public issues based on quantitative data. Ethical considerations of quantitative/computational thinking in cross-cultural civic/public issues. Course cannot be repeated for credit.
Corequisite(s): UH 4994
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2524 - Topics in Natural Sciences and Global Citizenship (3 credits)
Study of a specific branch of the natural sciences, especially as it intersects with public/civic controversies and problem-solving. Cross-cultural perspectives on the nature, purposes, and processes of scientific inquiry and knowledge. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2534, UH 2544, UH 2554, UH 4994
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2544 - Topics in Social Science and Global Citizenship (3 credits)
Study of the behavior and actions of individuals, groups, and institutions within larger social, economic, political, and geographic contexts, especially in cross-cultural settings. Special attention to social beliefs and actions as they influence public/civic controversies and problem-solving. Examination of the influence of value and beliefs on human behavior and social relationships. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2524, UH 2534, UH 2554, UH 4994
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2554 - Topics in Humanities and Global Citizenship (3 credits)
Analysis and interpretation of texts and other artifacts to understand ideas, values, and identities in cross-cultural contexts. Special attention to the functions of narrative and rhetoric in public/civic controversies and problem- solving. Situating local/regional texts and artifacts in global frameworks. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2524, UH 2534, UH 2544, UH 4994
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2604 - Intermediate Honors Quantitative and Qualitative Research Practices (3 credits)
Intermediate study of critical practices in quantitative and qualitative research for Honors College students, including identifying funding opportunities for research, collaborating across disciplines, designing introductory research protocols, managing research projects, and using posters to present research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2744 - Foundational Topics in Computing in Technology Innovation for Societal Impa (1 credit)
Foundational study of applications of computational thinking in technology innovation for societal impact. Key components of computing and their interrelation. Uses of computational thinking to frame questions and devise solutions. Implementation of simple computational processes and tools. Construction of computational models to analyze and draw inferences about complex and uncertain phenomena. Evaluation of knowledge based on quantitative data. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2754 - Advanced Topics in Computing in Technology Innovation for Societal Impact (1 credit)
Advanced study of applications of computational thinking in technology innovation for societal impact. Uses of computational thinking to frame questions and devise solutions. Application of computational processes and tools. Application and evaluation of computational models to analyze and draw inferences about dynamic and uncertain phenomena. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): MATH 1225 or MATH 1524 or MATH 1535
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2764 - Advanced Topics in Engineering in Technology Innovation for Societal Impact (1 credit)
Study of applications of computer and systems engineering in technology innovation for societal impact. Application of computer and systems engineering processes and tools to analyze complex or large-scale phenomena. Application and evaluation of computer and systems engineering approaches to analyze and draw inferences about the feasibility and effectiveness of technological innovations. Impacts of computer and systems engineering on society and the environment. Ethical dimensions of computer and systems engineering for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): UH 2744
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2814 - Topics in Social Sciences for Technology Innovation for Societal Impact (1 credit)
Threshold concepts in social sciences related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas about the behavior of individuals, groups, and institutions related to technology innovation within larger social, economic, political, and geographic contexts. Use of key concepts in the social sciences to examine the ethical dimensions of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2824 - Topics in the Arts for Technology Innovation for Societal Impact (1 credit)
Application of threshold concepts in the fine arts to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas for non-specialists about the formal elements, process, meaning, and value of the fine arts in technology innovation. Use of key concepts in the fine arts to examine the ethical dimensions of technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2834 - Topics in Humanities for Technology Innovation for Societal Impact (1 credit)
Threshold concepts in the humanities related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas and values related to technology innovation in various spatial, cultural, and temporal contexts. Use of key concepts in the humanities such as historical/cultural context and the nature of the good to examine the ethics of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2855 - Calhoun Transdisciplinary Fusion Studio (3 credits)
Introduction to transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 2855: Collaborative problem-setting. Evaluative criteria for technology innovation: feasibility (can it be made?), viability (is it financially sensible?), desirability (do people want it?), and sustainability (can it work long-term?). Introduction to design thinking. Ethical dimensions of collaborative technology innovation for societal impact. 2856: Collaborative problem-solving. Introduction to quantitative and qualitative research methods. Optimization and integration. Design thinking and component prototyping. Ethical dimensions of collaborative technology innovation for societal impact. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 2856 - Calhoun Transdisciplinary Fusion Studio (3 credits)
Introduction to transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 2855: Collaborative problem-setting. Evaluative criteria for technology innovation: feasibility (can it be made?), viability (is it financially sensible?), desirability (do people want it?), and sustainability (can it work long-term?). Introduction to design thinking. Ethical dimensions of collaborative technology innovation for societal impact. 2856: Collaborative problem-solving. Introduction to quantitative and qualitative research methods. Optimization and integration. Design thinking and component prototyping. Ethical dimensions of collaborative technology innovation for societal impact. Design Lab/Studio.
Prerequisite(s): UH 2855
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 3204 - Honors Service Learning (3 credits)
A two-part course. Part one: three hours a week working directly with community partners. Part two: a one-hour class to reflect on the service experience and discuss readings and other course materials that place the experiential learning into a theoretical context. Open to all Honors students. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

UH 3504 - Topics in Honors Transdisciplinary Seminars (3 credits)
Exploration of transdisciplinary issues and questions. Analysis of complex topics from multiple points of view. Collaborative discussion and critique. Ethical decision-making across disciplines. Application of knowledge and processes from other disciplines. Variable course content. May be repeated one (1) time with different content for a maximum of 6 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

UH 3604 - Designing Protocols for Honors Quantitative and Qualitative Research (3 credits)
Advanced study of critical practices in quantitative and qualitative research for Honors College students, including transdisciplinary project management, refining research protocols based on feasibility of data collection, maintaining research ethics and integrity, planning for data collection, and planning for dissemination of research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 3614 - Data Collection and Analysis for Honors Quantitative and Qualitative Research (3 credits)
Continuing advanced study of critical practices in quantitative and qualitative research for Honors College students, including working with multiple types of data, collecting, cleaning and managing data, reporting of primary and secondary data, evaluating the work of others, and communicating conclusions to general audiences.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 3855 - Calhoun Transdisciplinary Design Studio (3 credits)
Intermediate study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 3855: Systems thinking and systems definition; identification and analysis of stakeholders; skills discovery and transdisciplinary team building; rapid prototyping. 3856: Collaborative innovation; customer discovery; evidence-based decision-making; iterative design; troubleshooting. Design Lab/Studio.
Prerequisite(s): UH 2856
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 3856 - Calhoun Transdisciplinary Design Studio (3 credits)
Intermediate study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 3855: Systems thinking and systems definition; identification and analysis of stakeholders; skills discovery and transdisciplinary team building; rapid prototyping. 3856: Collaborative innovation; customer discovery; evidence-based decision-making; iterative design; troubleshooting. Design Lab/Studio.
Prerequisite(s): UH 3855
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 3954 - Study Abroad (1-19 credits)
Honors Section.
Instructional Contact Hours: Variable credit course

UH 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4004 - Honors Tutorial (3 credits)
Small, seminar-style course of one or a few students. Students explore a specific topic that is new to them with a faculty member who provides individual attention and is an expert in that established field. Open to all Honors students. Junior Honors standing. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

UH 4104 - Honors Student Teach Practicum (2 credits)
For Honors students facilitating Honors courses that encourage and require student facilitation or mentorship responsibilities. Student Teaching Assistants and their sections are overseen by honors faculty or staff. Student Teaching Assistants meet weekly with a member of the honors staff in a class designed to prepare them for the facilitation experience and to monitor their progress. Open to all Honors students, subject to Program approval. Sophomore Honors standing required. Variable course content. Repeatable for up to eight credits. P/F only.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)
Repeatability: up to 8 credit hours

UH 4504 - Topics in Honors Discovery and Innovation Studios (3 credits)
Discovery and definition of critical, real-world problems. Transdisciplinary collaboration, design thinking, and experimentation. Reflective evaluation of individual and collective problem-solving efforts. Communication of solutions to diverse stakeholders. Variable course content. Repeatable for up to 12 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

UH 4514 - Honors SuperStudio (1 credit)
Transdisciplinary collaboration. Identifying and defining public/civic issues. Framing and strategizing transdisciplinary solutions to public/civic problems. Reflecting on transdisciplinary processes. Identifying and reflecting on issues of ethics and equity in public/civic problem solving. May be repeated one time with different content for a maximum of two credit hours.
Corequisite(s): 4504 or enrollment in an approved disciplinary capstone course.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

UH 4704 - Honors Studio+ (3 credits)
Transdisciplinary and trans-sector collaboration in technology innovation. Identifying, defining, and setting problems in technology innovation. Applying evaluative criteria for technology innovation — feasibility, viability, desirability, sustainability. Using design thinking to analyze and reflect on creative processes. Identifying, articulating, and reflecting on the ethical dimensions of collaborative technology innovation. Design Lab/Studio (2H, 2L, 3C)
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4855 - Calhoun Transdisciplinary Capstone Studio (3 credits)
Advanced study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 4855: Systems building; project leadership and management, including resource allocation and scheduling; team management; value propositions; project pitches. 4856: User experience; user testing; systems assessment, including feasibility, viability, desirability, sustainability, optimization, and integration; systems reflection and documentation. Design Lab/Studio.
Prerequisite(s): UH 3856
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4856 - Calhoun Transdisciplinary Capstone Studio (3 credits)
Advanced study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 4855: Systems building; project leadership and management, including resource allocation and scheduling; team management; value propositions; project pitches. 4856: User experience; user testing; systems assessment, including feasibility, viability, desirability, sustainability, optimization, and integration; systems reflection and documentation. Design Lab/Studio.
Prerequisite(s): UH 4855
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

University Registrar (REG)

REG 1004 - Registrar Placeholder Course (3-6 credits)
Instructional Contact Hours: (3-6 Lec, 3-6 Crd)

REG 1234 - Testing Crosslisting Capabilities in Courseleaf CIM (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

Urban Affairs and Planning (UAP)

UAP 1004 - Introduction to Career & Professional Development in Public Service (1 credit)
This course introduces the academic requirements and potential career fields for the Environmental Policy and Planning (EPP) and Smart and Sustainable Cities (SSC) majors. It is designed to assist new and transfer students with academic planning, career exploration, and the job search process. In addition, students will develop an understanding of professional competencies and examine how these competencies relate to a potential occupational field. During the course, students will develop the materials and skills needed to successfully apply for an internship or job. These materials will include the preparation of a cover letter and resume that respond directly to a targeted position. The skills include interview and presentation techniques.
Instructional Contact Hours: (1 Lec, 1 Crd)

UAP 1024 - Leadership, Service, and Public Problem Solving (3 credits)
Current events and case studies on complex planning and policy issues challenging the United States. Historical, political, economic, social, and geographical context of the issues. Roles, relationships and responsibilities in governing, government, and the public policy process. Approaches to leadership and leadership styles. Professional ethics and the role of ethics in policy decisions. Dealing with competing values and public vs. interests in policy making.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 2004 - Principles of Real Estate (3 credits)
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: REAL 2004

UAP 2114 - Sustainability by Design (3 credits)
Design decision-making in complex contexts. Ethical issues underlying design for sustainability. Evaluation of design in systems, products, places, and modes of living using the Framework for Strategic Sustainable Development (FSSD). Historical and cultural underpinnings of design and sustainability.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARCH 2114

UAP 2334 - Urbanization and Biodiversity Conservation (3 credits)
Overview of challenges and opportunities that urban environments create for biodiversity conservation and human wellbeing, with a focus on social sciences theories and approaches. How urbanization is changing people's relationship with their environment and what that means for biodiversity conservation and human wellbeing. Examination of how data collection, analysis, and interpretation occur using social sciences methods applied to biodiversity conservation. Diversity, Equity, and Inclusion in the context of urbanization and conservation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FIW 2334

UAP 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 3014 - Urban Policy and Planning (3 credits)
An introduction to urban policy and urban planning. Includes analysis of the basic concepts and principles of urban policy, a review of urban policy in the United States, discussion of the development of urban planning and its role in shaping the urban environment, and an analysis of the relationship between public policy and planning and the organization and structure of the urban environment.
Prerequisite(s): UAP 1024
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3024 - Urban and Regional Analysis (3 credits)
Overview and application of various methods used to study, represent, understand communities in their urban and regional context. Data collection and analysis; population, land use, transportation and economic forecasting; selecting and applying an appropriate method; designing and presenting a community study. Restricted to majors and minors only.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3224 - Policy Implementation (3 credits)
Systematic analysis of the field and practice of public policy implementation. Includes analysis of the structure and dynamics of the policy process as well as specific analytic approaches to understanding policy implementation. Includes analysis of intra-organizational, interorganizational and intergovernmental implementation processes.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3264 - Contemporary Urban Issues (3 credits)
Consideration of one particular issue of immediate importance to the contemporary urban environment. Topics emphasize major social or economic policy issues, and may change each year. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3344, PSCI 3344

UAP 3354 - Introduction to Environmental Policy and Planning (3 credits)
Introduction to the interdisciplinary principles of environmental policy, planning, economics, and ethics to address pollution abatement, resources conservation, habitat protection, and environmental restoration. The course will focus on practical means of identifying environmental problems and creatively solving them.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3434 - Public Administration (3 credits)
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3414

UAP 3444 - Administrative Law and Policy (3 credits)
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3444

UAP 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464

UAP 3714 - The U. S. Policy Process (3 credits)
Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3714

UAP 3744 - Public Policy Analysis (3 credits)
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3744

UAP 3774 - Marxian Political Analysis (3 credits)
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3774

UAP 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4184 - Community Involvement (3 credits)
Issues, concepts, and techniques of citizen participation in community development. Institutional frameworks and their historical precedents. Exercises developing group communications skills, public meeting facilitation, and design of community involvement programs. Pre: Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4214 - Gender, Environment, and International Development (3 credits)
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4214, WGS 4214

UAP 4264 - Environmental Ethics and Policy (3 credits)
Issues in applied environmental ethics. Contributions of diverse religious and philosophical traditions to contemporary perspectives on the human-nature relationship. Examination of environmental policies from utilitarian economic, deep ecology, and ecofeminist perspectives. Junior, senior or graduate standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4344 - Law of Critical Environmental Areas (3 credits)
This course examines the legal principles and policy debates involved in the regulation and protection of critical environmental resources. Specific topics vary but will likely include wetlands law and policy, endangered species habitat, open space, forestland and farmland protection, coastal zone management, and floodplain regulation and policy.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4354 - Interdisciplinary Environmental Problem Solving Studio (3 credits)
Interdisciplinary, experiential problem-solving studio focusing on specific environmental problems. Working in groups, students interact with local officials, developers, environmental groups, and community organizations to explore the processes of environmental management, planning, and regulations. Students apply techniques and skills frequently used by environmental policymakers and planners. Pre: Senior standing.
Prerequisite(s): UAP 3354 and UAP 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4364 - Seminar in Environmental Policy and Planning (2 credits)
Critical examination of the social, political, economic, legal, scientific, and technological contexts underlying processes of environmental change, problems, and solutions, as seen from various conceptual and disciplinary perspectives. Senior status required and 9 credit hours, 3000-level or above, in the Environmental Policy and Planning major or minor.
Prerequisite(s): UAP 3354 and UAP 3224
Instructional Contact Hours: (2 Lec, 2 Crd)

UAP 4374 - Land Use and Environment: Planning and Policy (3 credits)
Environmental factors involved in land use planning and development, including topography, soils, geologic hazards, flooding and stormwater management, ecological features, and visual quality. Techniques used in conducting environmental land inventories and land suitability analyses. Policies and programs to protect environmental quality in land use planning and development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4384 - Pollution Control Planning and Policy (3 credits)
Planning and policy aspects of managing residuals and environmental contaminants and their effects on human health and environmental quality. Technical and economic factors involved in management of water quality, air quality, solid and hazardous wastes, toxic substances, and noise. Implementation of pollution control legislation, policies, and programs at federal, state, and local levels.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4394 - Community Renewable Energy Systems (3 credits)
Practical design fundamentals for small scale renewable energy systems: solar building heating and cooling; solar domestic hot water; wind, photovoltaic, and hydroelectric systems; alcohol, methane and other biomass conversion systems. Developing plans, programs, and policies to stimulate development of renewable systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4624 - The Washington Semester: Seminar in American Politics and Public Policy (3 credits)
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4624

UAP 4644 - Washington Semester: Politics, Policy and Administration in A Democracy (3 credits)
This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4644

UAP 4714 - Economics and Financing of State and Local Governments (3 credits)
Examines the provision and financing of public goods and services in local governments. Analyzes associated policy issues. Reviews experience in Western Europe and developing countries, as well as in the United States.
Prerequisite(s): UAP 3024 and (ECON 2005 or ECON 2005H) and (ECON 2006 or ECON 2006H)
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4754 - Legal Foundations of Planning (3 credits)
Examination of the legal context in which urban planning and public policy operate. Legal structure, role of law, powers of sovereign governments, constitutional limitations on government activities, and public-private conflict and their influence on planning and public policy are examined. Pre: Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4764, SOC 4764

UAP 4854 - Planning of the Urban Infrastructure (3 credits)
Course examines the interdependences among the elements of the built environment of the city and those between the elements of the built environment and the policy/planning structure of the city. Considered are those elements associated with the primary urban activities (residential, commercial, industrial) as well as the urban form-giving infrastructure facilities that support those land uses (water supply, sewerage, solid waste disposal, transportation, education, recreation, health, and safety).
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4914 - Seminar in Public and Urban Affairs (3 credits)
This capstone seminar explores the central questions of the role of the citizen and the citizenry in democratic capitalistic urban societies as well as the nature of accountability in such regimes. Topics such as the processes by which representation occurs, alternate theories of democratic community and the relationship of the public, private and civil sectors in urban society are treated. Senior status in PUA required. PUA majors and minors must complete this course with a C grade or higher to graduate; otherwise course must be repeated.
Prerequisite(s): UAP 4754 and SPIA 2554 and SPIA 3554
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4964H - Honors Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Water (WATR)

WATR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2004 - Water, Environment, and Society (3 credits)
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2004

WATR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 3104 - Principles of Watershed Hydrology (3 credits)
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earths surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing
Prerequisite(s): MATH 1026 or MATH 1226 or STAT 3005 or STAT 3604 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3104

WATR 3754 - Watersheds and Water Quality Monitoring (3 credits)
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems.
Prerequisite(s): (BIOL 1106 or BIOL 1006) and CHEM 1035 and FREC 2004 or (FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3754

WATR 4244 - Hydroinformatics (3 credits)
Analysis and examination of hydrologic data using basic statistics and computer programming. Calculation and interpretation of flow frequency and duration, hydrologic analysis of geospatial digital terrain data, and implementation and analysis of simple hydrologic models. Advanced methods of temporal and spatial hydrologic data visualization using computer programming.
Prerequisite(s): FREC 3104 or WATR 3104 or FREC 1044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4244

WATR 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4464, FREC 4464

WATR 4614 - Watershed Assessment, Management, and Policy (2 credits)
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: ALS 4614

WATR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Women's and Gender Studies (WGS)

WGS 1114 - Intro to LGBTQ+ Lives (3 credits)
Introduction to LGBTQ+ Identities and Activism. Analysis of art, history, politics, and media in relation to LGBTQ+ identities. Emphasis on identifying and interpreting intercultural human experiences related to sexuality and gender by examining how contexts change across time, through social practices, and in intersections with other identity categories.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 1824 - Introduction to Womens and Gender Studies (3 credits)
Describes feminism and the field of Womens and Gender Studies. Explains basic theories of social inequality, privilege, oppression and intersectionality. Discusses feminist perspectives on science and culture. Outlines womens and mens relative positions in and contributions to such institutions as family, work and the state.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 2114 - Feminist Theory (3 credits)
Examination of diverse theoretical perspectives on women and gender, including their historical origins and political implications. Special emphasis on integrative perspectives that also address race, class, and other dimensions of inequality.
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 2204 - Race and Gender in Religion and Culture (3 credits)
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social scientific approaches to investigate geographically variable historical and/or contemporary case studies.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2204, RLCL 2204

WGS 2224 - Creativity, Power, & Politics (3 credits)
Creativity, Power, & Politics analyzes the dimensions of creativity and the arts in the context of gender, sexuality, race, and class. Emphasis on identifying and interpreting intercultural human experiences related to the use of art in feminist social movements by examining how contexts change across time and in intersections with other identity categories.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 2254 - Feminist Activism (3 credits)
Explores the history of individual and collective action geared toward gaining womens rights and improving womens positions in society. Course covers tensions and shifts in feminist movements, as well as the perspectives, agendas, and actions of specific subgroups of women whose perspectives sometimes conflict. Service-learning is a required component of the course.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 2264 - Race, Class, Gender, and Sexualities (3 credits)
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2264, SOC 2264

WGS 2284 - Lesbian, Gay, Bisexual, Transgender and Queer Issues (3 credits)
Introduces students to Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ) Studies. Focuses on sexuality and gender as historical and cultural constructs. Examines the experiences of individuals who do not conform to binary sex-gender systems and the development of diverse identities and LGBTQ communities. Introduces feminist and queer theories that address LGBTQ issues within social, political, legal, and cultural institutions. Examines the institutional oppression of sexual minorities and implications of the intersectionalities of such systems of inequality as gender, race, ethnicity, class, age, and (dis)ability.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 3004 - Topics in Feminism (3 credits)
A variable topics course that addresses how the social construction of gender shapes social, cultural, political, economic, and institutional structures as well as individual experiences and perceptions. The course stresses interdisciplinary approaches to topics of emerging interest in feminist scholarship. Can be taken up to three times for credit with varying topic. In addition to WS 1824, must have taken a 2000-level Womens Studies course, or have instructors consent.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

WGS 3014 - Women and Gender in Islam (3 credits)
An examination of women and gender in Islam from a variety of perspectives including Muslim women in Islamic history, normative constructions of the roles of women in Islam, and womens role in contemporary Muslim societies. Understanding of women in classical Islam; feminist and reformist approaches; and Western constructions of the rights of women in Islam.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3014

WGS 3134 - Gender and Linguistics (3 credits)
Exploration of differences--real and imagined--in the speech of men and women, and the relationship between these differences to culture. Exploration of how language can reflect and reinforce gender inequality. Linguistic phenomena covered: pitch, vocabulary, sound change, language ideologies, and discourse strategies and types.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3134

WGS 3214 - Global Feminisms (3 credits)
An introduction to the gendered analysis of global womens issues with a special focus on women of color. Examines the multiple and diverse sites of feminist struggle within the third world, and between first and third worlds both in the U.S. and internationally. Studies the impact on women of political movements such as nationalism, colonialism, revolution, authoritarianism and democracy. Compares theories originating with women of color in the U.S. with those from international third worlds.
Prerequisite(s): WGS 2264
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4214 - Gender, Environment, and International Development (3 credits)
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4214, UAP 4214

WGS 4224 - Women's Studies Seminar (3 credits)
This multi-disciplinary, multi-cultural course examines a significant topic in Womens Studies, utilizing the perspectives of history, biology, psychology, political science, sociology, and the arts. Variable topics.
Prerequisite(s): WGS 1824 or WGS 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

WGS 4334 - Sexual Medicine (3 credits)
Discusses sex and medicine in contemporary U.S. society. Explores how notions of sexual behavior and normality are defined and structured by medical discourse. Examines cultural institutions that play significant roles in formulating ideas about and definitions of deviance, perversity, and tolerated marginality. Critiques medical responses to sexual variations. Examines experiences of people who have sought out, or been the unwilling victims of, sexual medicine. Junior standing required.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4334

WGS 4704 - Gender and Science (3 credits)
Investigates the gender dimensions of science in both historical and contemporary perspectives. Discusses feminist studies of science, exploring strengths and limitations. Assesses implications of cultural assumptions about gender for practicing scientists. A 3000 level course in science or engineering may satisfy prerequisite.
Prerequisite(s): WGS 2244 or STS 1504
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4704

WGS 4754 - Internship (1-6 credits)
Qualified students will be placed with a community agency or on-campus office which addresses contemporary issues of gender, class, and/or race, and will meet periodically with an appropriate faculty member to discuss assigned readings that will provide a context for the work experience. Students will also be expected to keep a journal and to write up a final evaluation of the experience. Variable credit: may be taken for up to 6 elective credits in the Womens Studies concentration. Junior standing, screening interviews with Tech faculty and with the service agency and consent required.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

WGS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

WGS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Financial Information

Auditing

Students are assessed the same rate for tuition and fees for auditing courses as for courses taken for credit.

Billing Statements (E-Bill)

Student Accounts are billed electronically. Current e-bills, e-bill history, and real-time current account activity are viewed in the e-billing system accessed through the student portal (Hokie SPA). E-bills are prepared at least monthly for new charges. Payment is required by due date on the statement to avoid penalties such as a late fee, registration hold, and cancellation of registration.

The initial e-bill for fall semester is posted mid-July and is due August 10. Updated e-bills are produced mid-August and again following the last day to add. Financial arrangements and payments must be in place to cover all charges no later than one week following the last day to add classes each semester to avoid cancellation of enrollment for the term. The initial e-bill for spring semester is posted in mid-December and is due January 10. After, a schedule similar to the fall e-bill schedule is followed. E-bills for the summer and winter terms will be posted at least one month prior to the start of each term.

Past due charges incur a late fee and will prevent access to drop/add and prevent pre-registration for the upcoming semester. In addition, past due charges from a prior semester incur finance charges.

Budget Tuition Plan

Virginia Tech's Budget Tuition Plan (BTP) offers a convenient method for planning and budgeting payment of tuition, fees, room, and board each semester. The BTP can cover all or part of the institutional charges. This plan provides the opportunity for the student or authorized family member to enroll in scheduled payments. The only cost for this service is a non-refundable application fee due with the application each semester. Students can join the BTP online through Hokie SPA. Please see **wallet.vt.edu** for additional information.

Bursar

The Office of the University Bursar is responsible for the billing of tuition, fees, housing, dining plans and many other student and related charges. Billing statements are electronically generated monthly (e-bill) and can be viewed on the student billing portal in Hokie SPA, where payment can be made by e-check, credit card, or payment plan if eligible. Payment can also be made by mail, in-person, or through Flywire (international payments).

Students may authorize parents or others as payers on their e-bill account. Unless revoked by the student, the payer receives the e-bill notification monthly and is able to view the account and make payments electronically to the student's account.

Release of Financial Information to a third party such as parent(s) and/or guardian(s) requires student authorization under the Family Educational Rights and Privacy Act (FERPA). The FERPA disclosure can be done via the Hokie SPA.

Detailed information is available on the Bursar's website www.bursar.vt.edu (http://www.bursar.vt.edu) and wallet.vt.edu.

Additional information on financial aid may be obtained by writing, calling, or visiting:

Virginia Tech Office of the University Bursar
Student Services Building, Suite 150
800 Washington St SW
Blacksburg, VA 24061
540-231-6277
Fax: 540-231-3238
bursar@vt.edu

Collection of Past Due Receivables for Students

Any amount owed to the university including, but not limited to, tuition, fees, room, board, loans, notes receivable, and amounts due for goods and services provided is considered a receivable to the university. A receivable becomes past due if payment is not received by the payment due date. At ninety days past due, the receivable becomes delinquent.

For currently enrolled students, the primary collection tool is the placement of a "**hold**" by the Office of the University Bursar on a student's record. This "**hold**" restricts certain student activities such as the ability to add or drop classes, receive diplomas, and registration for future academic terms. Once established, the "**hold**" remains in place until the debt is paid in full. When a student is no longer enrolled, the collection procedures utilized for other "non-student" receivables are implemented.

Individuals are responsible to pay all fees and charges owed to Virginia Tech. If the individual defaults on payment, has a returned check, e-check, or debit of said fees and charges, or has any delinquent amount owed, the individual must pay a penalty fee, interest at the highest rate allowed by law or as agreed to with Virginia Tech, and all reasonable administrative costs, collections fees, and attorney's fees incurred in the collection of amounts due the university. Students will be notified by an email sent to their Virginia Tech email address to alert them that a statement has been generated. Virginia Tech and their respective agents or contractors may contact individuals regarding any amounts owed, at the current or any future number provided for the cellular phone or other wireless device using automated telephone dialing equipment or artificial or pre-recorded voice or text messages.

Addresses must be kept current and can be changed by students as needed on Hokie SPA. Non-receipt of e-bill notification is not a valid defense for non-payment; it is the responsibility of the individual who has incurred the debt to see that the debt is discharged.

For non-students, a dunning message is included on each month's statement alerting the customer to the next collection steps that will be taken. If payment is not forthcoming within the stated period, the account and all pertinent information are forwarded to an outside collection agency for further collection efforts. In addition, the account is reported to national credit bureaus, thus affecting the debtor's credit rating.

In addition to the above measures, the university also lists the account with the Virginia Department of Taxation for set-off debt collection procedures. This means that any state income tax refund or payment processed through the State Treasurer's Office to the debtor will be reduced by the amount of the receivable owed by the debtor.

Eligibility for In-State Tuition

Eligibility for in-state tuition privileges and reduced rate tuition eligibility is governed by §§23.1-500 through 23.1-510 of the Code of Virginia. The provisions of §23.1-500 of the Code of Virginia are set forth, defined, and discussed in the State Council of Higher Education for Virginia's Domicile Guidelines **http://www.schev.edu/index/tuition-aid/in-state-residency/financial-aid-policy-and-procedures**. SCHEV developed these Guidelines to facilitate the consideration of uniform criteria in determining domiciliary status. §§23.1-500 through of the Code of Virginia places the responsibility on the student for establishing by clear and convincing evidence that s/he is eligible for the in-state tuition rate. Further, the burden is on the applicant to demonstrate by clear and convincing evidence that his/her domicile is Virginia and that s/he has abandoned any prior domicile. According to SCHEV's Guidelines, clear and convincing evidence is defined as "that degree of proof that will produce a firm conviction or a firm belief as to the facts sought to be established. The evidence must justify the claim both clearly and convincingly." Please visit SCHEV's website at **http://www.schev.edu/index/tuition-aid/in-state-residency** for additional information.

Residence or physical presence in Virginia primarily to attend the university does not entitle students to in-state tuition rates. Domicile for tuition purposes should be established before one enters the University. Please note that if a student enters the University classified as an out-of-state student, the student must present clear and convincing evidence to rebut the presumption that they are residing in the state primarily to attend school. Students seeking reclassification to in-state status must be prepared to pay the out-of-state tuition rate unless they are notified in writing that their status has been reclassified to in-state tuition.

Domicile classification is determined at the time of a student's admission to Virginia Tech. Undergraduate transfer and freshman applicants for admission apply for in-state status at the time they apply to Virginia Tech. For additional information please contact:

Office of Undergraduate Admissions
925 Prices Fork Road, Mail Code 0202
Blacksburg, VA 24061
https://vt.edu/admissions/undergraduate.html
(540) 231-6267
domicile@vt.edu

Continuing or returning undergraduate students classified as out of state who believe they qualify for in-state tuition may apply for changes in residency status through the Office of the University Registrar by completing the Application for Virginia in-state tuition rates. Applications must be received prior to the first day of class for the semester that in-state tuition privileges are sought. Please email **residency@vt.edu** for additional information. For additional information please contact:

Office of the University Registrar
Suite 250 Student Services Building
800 Washington Street, SW, Mail Code 0134
Blacksburg, VA 24061
www.registrar.vt.edu
(540) 231-6252
residency@vt.edu

The regulations governing domicile are determined by state law, and are therefore subject to change. The information stated herein is not intended to be a contract between a student and Virginia Tech but is provided for informational purposes only.

Eligibility for In-State Tuition Rates through the Veterans' Choice Act of 2014

A Veteran using educational assistance under either chapter 30 (Montgomery G.I. Bill® – Active Duty Program) or chapter 33 (Post-9/11 G.I. Bill®), of Title 38, United States Code, who lives in the Commonwealth of Virginia while attending a school located in the Commonwealth of Virginia (regardless of his/her formal State of residence) and enrolls in the school within three years of discharge from a period of active duty service of 90 days or more. *GI Bill® is a registered trademark of the U.S. Department of Veterans Affairs (VA).*

Anyone using transferred Post-9/11 GI Bill® benefits (38 U.S.C. § 3319) who lives in the Commonwealth of Virginia while attending a school located in the Commonwealth of Virginia (regardless of his/her formal State of residence) and enrolls in the school within three years of the transferor's discharge from a period of active duty service of 90 days or more.

Anyone using transferred Post-9/11 GI Bill® benefits who lives in the state where the IHL is located and the transferor is a member of the uniformed service who is serving on active duty.

A spouse or child using benefits under the Marine Gunnery Sergeant John David Fry Scholarship (38 U.S.C. § 3311(b)(9)) who lives in the Commonwealth of Virginia while attending a school located in the Commonwealth of Virginia (regardless of his/her formal State of residence).

An individual using educational assistance under chapter 31, Vocational Rehabilitation and Employment (VR&E) who lives in the Commonwealth of Virginia while attending a school located in the Commonwealth of Virginia (regardless of his/her formal State of residence) effective for courses, semesters, or terms beginning after March 1, 2019.

Anyone described above while he or she remains continuously enrolled (other than during regularly scheduled breaks between courses, semesters, or terms) at the same institution. The person so described must have enrolled in the institution prior to the expiration of the three-year period following discharge or release as described above and must be using educational benefits under either chapter 30, chapter 33, or chapter 31 of title 38, United States Code.

Grievance Policy

"The Virginia State Approving Agency (SAA), is the approving authority of education and training programs for Virginia. Our office investigates complaints of GI Bill® beneficiaries. While most complaints should initially follow the school grievance policy, if the situation cannot be resolved at the school, the beneficiary should contact our office via email **saa@dvs.virginia.gov**."

Enrollment Status (Full Time)

Certification of full-time student status, for most purposes, U.S. Department of Veterans Affairs (V.A.) educational benefits, Social Security benefits, loans, scholarships, and grants, is based on the following enrollment information: official undergraduate and College of Veterinary Medicine enrollment for each regular semester must be 12 or more credit hours and official graduate enrollment for each regular semester must be 9 or more credit hours. All courses must be in the A/F option, P/F option, or equivalent credit. Please note that courses taken under the audit option do not count toward the enrollment status. Participation in the Virginia Tech Cooperative Education program, National Student Exchange program, and International Student Exchange program reflects full-time enrollment. Certification of enrollment for V.A. educational benefits will reflect only those hours considered to be progress toward the degree or educational objective. Although considered to be enrolled full-time, students who participate in the Cooperative Education program are not eligible for V.A. educational benefits or federal financial aid during the terms in which they participate in the Co-Op program.

Students Receiving Veterans Education Benefits

Once Virginia Tech receives a valid VA authorization, such as a VAF 28-1905 for Chapter 31 VR&E beneficiaries, Certificate of Eligibility (COE) or "Statement of Benefits" for Chapter 33 Post 9/11 GI Bill® recipients, and the student has submitted a request to use such entitlement, the covered student will be permitted to participate in the approved course(s) while awaiting payment from the VA for a period of 90 days from the date Virginia Tech submits a valid invoice for tuition/fees (T&F) to VA. For attendance costs a student's Veterans Affairs benefits will cover, Virginia Tech will not impose any penalty, including the assessment of late fees; the denial of access to classes, libraries or other institutional facilities; or require any covered individual to borrow additional funds due to delayed T&F payments from the VA.

Medical Resignations

A student resigning for medical reasons will be charged a daily tuition rate for each day enrolled.

Resignations for medical reasons must be accompanied by a recommendation from Schiffert Health Center or Cook Counseling Center at Virginia Tech or a medical professional indicating the student is unable to continue in school due to medical reasons. Recommendations should be forwarded to the student's academic dean. It is the purview of the Academic Dean to approve the recommendation.

Military Withdrawals

Students called into active military duty are encouraged to communicate with their advisors, instructors, and undergraduate or graduate deans to arrange "incompletes" or rescheduling of remaining work if their orders are received near the end of a term. However, if students request a withdrawal from the university, permission is granted without punitive action as well as granting a full refund of tuition and fees. This full refund is requested regardless of the date of the action of withdrawal. Procedurally, students (or their parents or guardians) are requested to provide copies of activation orders. If orders are unobtainable (in some emergency call-ups, this is possible), the University Registrar will telephone the company commander for verbal confirmation. Further, the University Registrar will serve as facilitator of this process for any advisor, instructor, or dean seeking verification of the students' military status. Students with Federal Financial Aid should be advised that full refund of tuition will result in an immediate requirement to commence repayment of aid. Students with federal financial aid are to be given the option of full or partial refund. Students are to work with their advisors and deans in requesting reinstatement to the university.

Reinstatement: All students leaving under the military withdrawal policy are entitled to reinstatement into the same program of study. Students are directed to seek advising from their advisors or academic deans.

If absent more than five years, certain majors may require re-taking of specific major courses.

Defer Initial Enrollment: Students called up for active duty may defer initial enrollment (in the same major) if:

- The student returns to Virginia Tech after a cumulative absence of not more than five years, and
- The student provides notice of intent to return to Virginia Tech not later than three years after completion of the period of service.

Payment Directions

The most efficient and direct methods of payment include electronic payments as accessible in the e-bill system and the Budget Tuition Plan.

If paying by mail, please make the check payable to Treasurer of Virginia Tech. Print the PDF version of the e-bill and enclose the remittance advice with your check to ensure proper payment application. Mail to:

Virginia Tech Office of the University Bursar
Student Services Building, Suite 150
800 Washington Street SW
Blacksburg, VA 24061

When mailing payment, please do not send cash. See wallet.vt.edu (http://wallet.vt.edu/) for additional payment options.

Refund Policy

Virginia Tech requires that payment of wages or salaries, travel or expense reimbursement, and student refunds be processed by direct deposit into an account in the name of the student at a financial institution in the United States designated by the student. The student can enroll in direct deposit online through Hokie SPA under the Hokie Wallet menu. Refund processing priority is given to students enrolled in direct deposit. If the student has not provided bank account information, a refund check will be mailed to the permanent address listed on Hokie SPA at the time the refund is processed. Requests for replacement refund checks must be in writing and will not be accepted until 14 calendar days after the date the original check was issued and mailed.

Refunds (Room and Board)

Students holding a residence hall contract who leave the university during the first week of class will forfeit $100 of their residence hall fee. Thereafter, the semester room charge, less $100, will be apportioned over the first six weeks of the semester. A student who withdraws after the Friday of the sixth week of the semester will be charged the full room and board rate. Any eligible refund accrual is based on the room check-out date.

Students who purchase a declining balance dining plan will be charged a forfeiture fee of $100 during the first week for a Major, Mega, or Premium dining plan and $35 during the first week for a Minor Flex or Commuter Cash dining plan. Beginning in week two and throughout the remainder of the semester, students will forfeit the base cost and will be refunded any unused dollars in the declining balance account. Commuter Cash dining plan holders will receive a refund of the remaining dollars on the plan less a $35 forfeiture fee. Refunds are calculated from the date the resignation is processed by the university or the last day of dining plan use, whichever is later. No refund will be granted for a resignation backdated for a previous semester.

Students with a balance in a Dining Dollars, Flex Additions, or Hokie Passport account will receive a credit on their student account of the balance less a $15 processing fee per account. Questions concerning adjustments to room charges should be directed to Housing Services at (540) 231-6205. Questions concerning adjustments to dining plan charges should be directed to Hokie Passport Services at (540) 231-5121.

Refunds (Tuition)

The refund schedules below list the student refund for withdrawals, resignations, and reduced course load for the fall and spring semesters. Schedules by calendar day as well as schedules for winter and summer are published on the bursar's website under Refund Policy. Students considering reducing their course load or resigning should always review examples of the calculation of any refund before actually dropping the course or resigning. Students receiving financial aid should contact the University Scholarships & Financial Aid Office prior to dropping the course to determine the impact on their financial aid.

Fees are defined as the comprehensive fees (full or part time) and any laboratory or resource fee associated with a particular course. When dropping a course, please note the non-refundable nature of fees after the first week of classes. Tuition and fee refunds for resignations are based on the effective date of resignation. If there is a question related to the effective date of resignation, the student should contact their college.

Tuition Refund Schedule for Reduced Course Loads

Semester Class Day	Student Refund
One - Five	100% of Tuition and Fees
Six - Eight	90% of Tuition and Fees
Nine - Nineteen	50% of Tuition and Fees
Twenty - Thirty-Seven	25% of Tuition and Fees
After day Thirty-Seven	0%

Tuition Refund Schedule for Withdrawals & Resignations

Semester Class Day	Student Refund
One	100% of Tuition and Fees
Two - Eight	90% of Tuition and Fees
Nine - Nineteen	50% of Tuition and Fees
Twenty - Thirty-Seven	25% of Tuition and Fees
After day Thirty-Seven	0%

- All refunds will be calculated from the official date of resignation, which may not necessarily be the last day of class attendance. No refund will be granted for retroactive/back-dated resignations.

Financial Aid & Programs

Virginia Tech awards financial aid to eligible students in the form of scholarships, grants, loans, and employment. The majority of financial aid is intended for fulltime students with financial need.

To apply, entering freshmen, transfer students and returning Virginia Tech students should submit the Free Application for Federal Student Aid (FAFSA) electronically at www.studentaid.gov (https://www.undergradcatalog.registrar.vt.edu/2122/www.studentaid.gov). The Office of University Scholarships and Financial Aid's priority deadline is March 1 for the upcoming academic year. The FAFSA opens on October 1 each year.

The priority deadline applies to all financial aid programs except the Federal Pell Grant, Federal Direct Subsidized and Unsubsidized, Federal Direct Grad PLUS and Federal Direct Parent PLUS Loan Programs.

Applicants for scholarships and financial aid must select Virginia Polytechnic Institute & State University or enter VT's institutional school code number, 003754, on the FAFSA for FAFSA results to be sent to Virginia Tech. Students must complete and submit a new FAFSA each year to be considered for financial aid at Virginia Tech.

All offers of financial aid are contingent upon receipt of anticipated federal and state funds by the university. Awards may be reduced or canceled if anticipated funds are not received. Offers of financial aid are subject to full-time enrollment (12 credit hours per term for undergraduates and 9 credit hours per term for graduate students) and the student meeting Satisfactory Academic Progress Policy requirements.

Eligibility Requirements

To be eligible to receive aid from institutional, state, and federal need-based programs, an applicant must meet the following eligibility requirements: enroll or be accepted for enrollment as a degree-seeking student; be a U.S. citizen or an eligible non-citizen; submit a complete FAFSA; and meet the financial aid Satisfactory Academic Progress Policy for Title IV recipients. Full-time enrollment is required for the majority of federal, state, and institutional programs. Students should consult with a financial aid advisor to determine how financial aid will be impacted for less than full time enrollment.

Federal Title IV Programs

The FAFSA is the application for all federal financial aid programs.

Federal Work-Study Program: This federal program provides employment opportunities to students with demonstrated financial need. Eligible undergraduate and graduate students are limited to 20 hours of work per week while classes are in session. All Federal Work-Study Program jobs pay at least minimum wage.

Federal Direct Loan Programs: This federal program encompasses Federal Subsidized, Unsubsidized, Graduate PLUS, and Parent PLUS Loans.

- Federal Subsidized and Unsubsidized Loans are long-term; low-interest loans guaranteed by the federal government for the educational expenses of eligible students enrolled at least half-time. Repayment begins six months after the student ceases at least half-time enrollment.
- Federal Parent PLUS Loans are available to parents of undergraduate dependent students enrolled at least half-time. Parents may borrow up to the cost of attendance minus any financial aid for which the student qualifies. You must apply at www.studentaid.gov (https://www.undergradcatalog.registrar.vt.edu/2122/www.studentaid.gov) and an approved credit check is required.
- Federal Graduate PLUS Loans provide additional loan funds to graduate students that have exhausted eligibility in the Federal Unsubsidized Student Loan Program. You must apply at www.studentaid.gov (https://www.undergradcatalog.registrar.vt.edu/2122/www.studentaid.gov) and an approved credit check is required.

Federal Pell Grant Program: Federal Pell Grants are awarded to undergraduate students with high financial need. This program provides grant support to lower income families. Students must be pursuing a first bachelor's degree to receive the Federal Pell Grant.

Federal Supplemental Educational Opportunity Grant: Virginia Tech awards this federal grant to undergraduate students with extraordinary financial need. These funds are restricted to Pell-eligible students.

Commonwealth of Virginia Programs

Virginia Guaranteed Assistance Program: Grants of up to the cost of tuition are awarded by Virginia Tech from funds administered by the State Council of Higher Education for Virginia. Awards are made to eligible undergraduate residents of Virginia with demonstrated financial need. The list of requirements for this grant are available on our website.

Commonwealth Award: Awards are made by Virginia Tech from funds administered by the State Council of Higher Education for Virginia to Virginia residents seeking a first bachelor's degree with demonstrated financial need. The list of requirements for this grant are available on our website.

Two-Year College Transfer Grant: The Two-Year College Transfer Grant is administered by the State Council of Higher Education for Virginia. These grants are for undergraduate state residents who transfer from a community college with a 3.0 Grade Point Average (GPA) after completing an Associate's Degree at a Virginia two-year public institution. Recipients must maintain a 3.0 GPA and meet other requirements listed on our website.

The Virginia Military Survivors and Dependent Education Program: The Virginia Military Survivors and Dependents Education Program provides tuition and fee educational assistance for a maximum of 8 semesters or four academic years to spouses and children of military service members killed, missing in action, taken prisoner, or who became at least 90 percent disabled as a result of military service in an armed conflict. This program was formerly named the Virginia War Orphans Education Program. To be eligible for assistance, application is made to the Virginia Department of Veterans Services.

Academic Scholarships and Grants: Scholarships are for select undergraduate students who establish an outstanding academic record, including incoming freshmen, through colleges and academic departments. Please refer to the scholarship section of our website for additional information. USFA offers the General Scholarship application through the electronic Scholarship Central portal at https://finaid.vt.edu (https://finaid.vt.edu/). This application is available August 1 and **the deadline is January 22**.

Athletic Scholarships: Admission and enrollment of students who are candidates for financial aid for which athletic ability is a consideration shall be conditional upon compliance with applicable regulations of the Atlantic Coast Conference and the National Collegiate Athletic Association.

Veterans Affairs Educational Benefits (GI Bill®): Applicants who wish to receive VA Educational Benefits should contact the Office of Veterans Services or visit www.veterans.vt.edu (https://www.undergradcatalog.registrar.vt.edu/2122/www.veterans.vt.edu). Application information for veterans' benefits may be obtained from the nearest regional office of the Veterans' Administration. Students must enroll for a minimum of 12 credits each term to receive benefits as full-time students.

Additional Information

Additional information on financial aid and scholarships may be obtained by contacting:

The Office of University Scholarships and Financial Aid
Student Services Building, Suite 200
Virginia Tech
800 Washington Street SW
Blacksburg, VA 24061
Phone: (540) 231-5179
Fax: (540) 231-9139
E-mail: finaid@vt.edu
Website: https://finaid.vt.edu (https://finaid.vt.edu/)
Student Consumer Information: https://aie.vt.edu/strategic-analysis/public-disclosure-requirements/student-consumer-information.html

All information is correct at the time of publication. Current information is available from the Office of University Scholarships and Financial Aid (https://finaid.vt.edu/) website.

General Information

Mission of the University

Inspired by our land-grant identity and guided by our motto, Ut Prosim (That I May Serve), Virginia Tech is an inclusive community of knowledge, discovery, and creativity dedicated to improving the quality of life and the human condition within the Commonwealth of Virginia and throughout the world.

Athletics, Intramurals, and Recreational Facilities

Virginia Tech has a diverse and highly active athletic program for men and women students in intercollegiate, intramural, and extramural sports. The athletic program is recognized as one of the most successful in the nation because it is geared to meet the needs of all students interested in physical and recreational sports activity.

The university has extensive and modern athletic and recreational facilities, including:

- Cassell Coliseum, an indoor arena seating 8,925
- Lane Stadium, seating 65,632
- a fully equipped recreation gymnasium, including War Memorial Pool
- Rector Field House
- Burrows-Burleson Tennis Center
- English Field at Atlantic Union Bank Park
- outdoor tennis courts
- the Pete Dye River Course of Virginia Tech and Virginia Tech Golf Course
- Johnson-Miller Track Complex
- Thompson Field for Soccer/Lacrosse
- Tech Softball Park
- a pond for ice skating in the winter
- South Recreation Field Area for outdoor sports

Virginia Tech's athletic varsity teams compete at the Division I level of the National Collegiate Athletic Association (NCAA). The university participates in the Atlantic Coast Conference for all varsity sports. Athletic scholarships are available in the following intercollegiate sports:

- Baseball (men)
- Basketball (men and women)
- Football (men)
- Golf (men and women)
- Lacrosse (women)
- Soccer (men and women)
- Softball (women)
- Swimming and Diving (men and women)
- Tennis (men and women)
- Indoor/Outdoor Track and Field/Cross Country (men and women)
- Volleyball (women)
- Wrestling (men)

The following extramural sports clubs also are available:

- baseball (men's)
- basketball
- bowling
- clay target
- competitive cheerleading
- crew
- cricket
- cycling
- equestrian
- fencing
- golf
- women's field hockey
- gymnastics
- ice hockey
- lacrosse
- roller hockey
- rugby
- soccer
- softball (women's)
- snow skiing
- tennis
- triathlon
- volleyball
- water polo
- wakeboard

Virginia Tech offers a wide range of intramural and recreational programs for men and women including the following sports:

- basketball
- billiards
- bowling
- chess
- dodgeball
- fantasy football
- flag football
- hearts tournament

- racquetball
- golf
- innertube water polo
- kickball
- soccer
- softball
- swimming
- table tennis
- tennis
- team darts
- ultimate frisbee
- volleyball
- wallyball
- wiffleball

Venture Out provides fun, safe, and educational outdoor services to the university community. Venture Out specializes in low-risk outdoor adventures, quality rental gear at unbeatable rates, and valuable resource materials. Venture Out is a healthy recreational alternative and allows the university community to enjoy all that Southwest Virginia has to offer, from hiking and camping, to kayaking, horseback riding, mountain biking, and skiing.

Venture Out
Phone: (540) 231-4982
E-mail: ventureout@vt.edu
Web: www.recsports.vt.edu/content/venture-out (http://www.recsports.vt.edu/content/venture-out/)

Cadet System

The Virginia Tech Corps of Cadets is one of only two programs in the United States offering a corps of cadets within a large public university. The Corps of Cadets (https://vtcc.vt.edu/), a militarily structured organization, offers many leadership development opportunities to both male and female students. The Rice Center for Leader Development offers a minor in leadership studies. Contact CAPT Jamie McGrath, USN(Ret), Director, (540) 231-9455 for additional information on the Rice Center.

The Corps is supervised by the Commandant of Cadets, who establishes overall policies and methods of operation for the Corps. The cadet commanders and staff officers are responsible for implementation of policies and procedures and the day-to-day operations of the Corps.

Membership in the Corps involves a 24-hour-a-day commitment. Members wear a distinctive Virginia Tech cadet uniform and live in designated cadet residence halls. Both cadets and non-cadets are part of one student body, attend the same classes, and are organized into one student government. Cadets participate in all university activities, including athletics, social events, and cultural programs. Membership in the Cadet Regimental Band, the "Highty-Tighties," is restricted to cadets. Although many benefits are available through participation in one of the three ROTC programs offered at Tech, a student does not have to enroll in an ROTC program to be a member of the Corps of Cadets.

Career and Professional Development

Career and Professional Development works with students of all academic levels and all majors/degree programs to assist with the following:

- **Making career decisions and plans.** Whether students are trying to decide on an academic major or a career field, Career Advisors on staff are ready to assist. Self-assessment tools are used to help students identify their unique strengths, interests, values, and personality type. Students can find a variety of career information through the Career and Professional Development web site (www.career.vt.edu (http://www.career.vt.edu)) and in the Career Resource Library in the Smith Career Center.
- **Gaining career-related experience while in school.** Increasingly, employers expect students to have experience in their chosen field before graduation. In addition to administering the Cooperative Education and Internship Program (detailed below) and Campus internEXP (an on-campus internship program), Career and Professional Development provides hundreds of internship job listings through Handshake, their on-line resume referral and job listing database.
- **Determining post-graduation career plans.** This typically involves seeking full-time employment or applying to graduate or professional school. Career and Professional Development offers a full range of services related to educating students about the job search process including resume and cover letter critiques, practice interviews, seminars on business etiquette, and more. Through Handshake, students have access to thousands of job listings and opportunities to connect with employers through the On-Campus Interviewing Program. Additionally, Health Professions Advising is located within Career and Professional Development and is dedicated to assisting students who are interested in continuing their education to pursue a health-related occupation. (www.career.vt.edu/hpa (http://www.career.vt.edu/hpa/))

Information about all of Career and Professional Development's resources, services and programs - including an events calendar - is located at www.career.vt.edu (http://www.career.vt.edu). To meet with a Career Advisor to discuss any of these topics, students can schedule an appointment through Handshake, by calling (540) 231-6241, or by visiting Career and Professional Development. Career and Professional Development is located in the Smith Career Center on the corner of Washington Street and West Campus Drive.

Cooperative Education & Internship Program

The Cooperative Education & Internship Program (CEIP) is an academic program that provides students the opportunity to combine real world work experience with classroom theory. It involves one or more semesters of paid or unpaid, full-time or part-time work and is a partnership among the student, Career and Professional Development, the academic department, and the employer. Gaining career-related experience gives the cooperative education or internship student the opportunity to test career goals, develop key experiences and skills, defray the costs of a college education, and gain an important edge for the post-graduation job market. The student transcript will indicate Cooperative Education and Internship Program enrollment during the term(s) worked.

The CEIP Orientation is required of all students who plan to enroll in the Cooperative Education & Internship Program. Seminars are scheduled throughout the year and are designed to walk prospective co-op and internship students through the process of enrollment in the CEIP. Please call (540) 231-6241 or visit career.vt.edu/experience/ceip.html (http://career.vt.edu/experience/ceip.html) to find out more.

Requirements for Participation in the CEIP

- Students must maintain a cumulative GPA of 2.0.
- Students can begin work the summer after their freshman year. Transfer students must have completed at least one semester and earned a GPA of at least 2.0 at Virginia Tech.
- The co-op or internship job can be a full-time or part-time opportunity.

Additional Notes

- The CEIP is open to any undergraduate student in any major.
- The Graduate School administers the graduate Co-op and Internship Program.
- To see where our current students are working, visit https://reports.career.vt.edu/EmployersListByMajor?orderBy=ASC&sortBy=StudentMajor (https://reports.career.vt.edu/EmployersListByMajor/?orderBy=ASC&sortBy=StudentMajor)

Counseling Center (Thomas E. Cook Counseling Center)

2475 Oak Lane, 107 East Eggleston Hall, 202 S. Main Street (Kent Square), 4505 North End Center, Riverside 1- 2nd floor, Roanoke; and National Capital Region (Falls Church campus)

The Thomas E. Cook Counseling Center is accredited by the International Association of Counseling Services and provides a full range of mental health services to all undergraduate and graduate students on the Blacksburg campus and the Roanoke (Riverside 1) campus. Services include crisis intervention, individual and group counseling, and psychiatric care. Cook Counseling Center also offers consultation services for students, parents, faculty, and staff; 24/7 after-hours emergency on-call services; mental health outreach including peer assistance programs; and online screenings.

The Cook Counseling Center consists of a multidisciplinary staff and all services are provided under the direction of licensed, credentialed and experienced mental health professionals and support staff. Confidentiality is an essential aspect of the counseling relationship between Cook Counseling Center staff and students. Confidentiality in the counseling relationship is protected by ethical principles and under legislative code in the Commonwealth of Virginia; information shared in counseling may only be released with the written permission of the student.

Through the provision of mental health services, the Cook Counseling Center provides opportunities for students to learn more about themselves as individuals, form deeper relationships with their peers, and grow to benefit our community and society-at-large. Cook staff members are aware of and respect cultural, individual, and role differences, including those based on age, gender, gender identity, race, ethnicity, culture, national origin, religion, sexual orientation, gender expression, disability, language, and socioeconomic status and consider these factors when working with students.

The Cook Counseling Center services are covered by payment of the student health fee. An appointment can be made by calling (540) 231-6557 or stopping by the office located in 2475 Oak Lane.

Cook Counseling Center | 540-231-6557 | ucc.vt.edu (http://ucc.vt.edu) | counseling@vt.edu

Cultural and Community Centers

As a department within Student Affairs, Cultural and Community Centers' programs, policies, and personnel create the conditions for underrepresented student success and to develop the cultural competence of every Virginia Tech student. We achieve this mission through advocacy, advising, and awareness.

Cultural and Community Centers hosts six centers, all located in the Squires Student Center. Students of every culture are encouraged to visit the centers and engage in conversation. The centers are:

- American Indian and Indigenous Community Center (AIICC)
- Asian Cultural Engagement Center
- Black Cultural Center
- El Centro Hispanic/Latino Center
- Intercultural Engagement Center
- LGBTQ+ Resource Center

Cultural and Community Centers' hosts a Community Kick-Off each fall to welcome students, faculty, and staff in identity-based communities, history and heritage months, and cultural achievement ceremonies each spring.

In addition, our team is available to provide informal advising to any student or student organization that feels they might fit within the scope of our mission.

Through programs and events, Cultural and Community Centers increases awareness of underrepresented students' experiences and develops opportunities to gain cultural competence for every Virginia Tech Student.

Cultural and Community Centers | 540-231-8584 | ccc.vt.edu (http://ccc.vt.edu) | vtccc@vt.edu

Dean of Students Office

The Dean of Students office serves as advocates for students and their support networks in times of personal, academic, and community crisis.

We know that life doesn't stop while students are in college. When life throws challenges in students' way, we're here to help them create plans, connect to resources, and gain the confidence to get back on track. We work with students, families, friends, and faculty. We're a friendly, caring team ready to listen and assist. We welcome referrals, appointments, and walk-ins.

A member of the Dean's Staff is on-call 24 hours a day, seven days a week. Between the hours of 8 a.m. and 5 p.m., call the Dean of Students office at 540-231-3787. After hours, the on-call staff member from Dean's Staff may be reached by calling the Virginia Tech Police at 540-231-6411, press 1.

Dean of Students | 540-231-3787 | dos.vt.edu (http://dos.vt.edu) | dean.students@vt.edu

First-Year Experiences

Virginia Tech's signature first-year experience (FYE@VT) initiative includes courses specific for first time first-year and transfer students. Uniquely housed in the academic unit, and each uniquely consistent with the strategic direction, mission, and culture of that unit; these courses support students in their academic transition to college by introducing

them to their chosen discipline/major, faculty in their major, and available resources on campus.

The courses are anchored by four foundational Cornerstones:

- **Academic transition** - introduce the discipline, the practice of learning from experience, and the resources for successful academic transition to Virginia Tech;
- **Holistic education** - integrate experiences inside and outside of the classroom for a meaningful, holistic student experience;
- **Integrity** - develop academic and personal integrity; and
- **Community** - foster a connection to the discipline and to Virginia Tech.

FYE@VT offers students integrated academic and social opportunities designed to promote the complex thinking and ethical abilities necessary for success in a global community. These opportunities enable students to investigate the world around them, resulting in a stronger sense of self, values, community and potential. FYE@VT leverages five essential practices for transitioning students to learn skills necessary to be successful in the discipline.

1. **Effective Teaching & Learning** FYE@VT courses are intentionally designed to use research-based learning experiences to foster student engagement and to support the development and success of first-year students.
2. **Virginia Tech Principles of Community** FYE@VT courses introduce students to and are conducted in the spirit of the Virginia Tech Principles of Community and Ut Prosim (That I May Serve).
3. **Mentorship & Engagement** FYE@VT courses demonstrate diverse ways of reinforcing an engaged campus through connecting students to curricular, social, co-curricular and cultural enrichment opportunities.
4. **Digital & Information Literacies** FYE@VT courses help students create connections with University Libraries to enhance their ability to discover, create, reflect, evaluate, and communicate knowledge to diverse audiences.
5. **Undergraduate Academic Integrity** FYE@VT courses support individual understanding and the ability to adhere to the principles of academic integrity when using and/or creating information in accordance with the Virginia Tech Honor Code and professional norms of their field.

A description of each program with contact information can be found at http://www.fye.vt.edu.

Global Travel Insurance & Emergency Assistance

Under University Policy 1070, http://www.policies.vt.edu/1070.pdf , all Virginia Tech students participating in university supported global travel are required to carry international medical and emergency assistance insurance. To meet this requirement, the university has contracted with an insurance provider CISI.

Some of the benefits of the Cultural Insurance Services International (CISI) policy include:

- Security & Natural Disaster Evacuation
- Repatriation
- Emergency Medical expenses, medical evacuation, & medical reunion

Those traveling internationally in a group for a formal education and study abroad program should refer to the Virginia Tech Global Education website at https://www.globaleducation.vt.edu for insurance requirements.

Those traveling internationally on Virginia Tech business, not in a study abroad program, should refer to Virginia Tech Risk Management website at http://risk.controller.vt.edu/vi/international.html.

Honor Code and Honor System

The Honor Code is the university policy which defines the expected standards of conduct in academic affairs. The Virginia Tech Honor Code embodies a spirit of mutual trust and intellectual honesty that is central to the very nature of the university and represents the highest possible expression of shared values among the members of the university community.

The fundamental beliefs underlying and reflected in the Honor Code are: that trust in a person is a positive force in making that person worthy of trust, that every student has the right to live in an academic environment that is free from the injustices caused by any form of intellectual dishonesty, and that the honesty and integrity of all members of the university community contribute to its quest for truth.

The functions of the Honor System are to communicate the meaning and importance of intellectual honesty to all students of the university; to articulate and support the interest of the community in maintaining the highest standards of conduct in academic affairs; and to identify, sanction, and educate those who fail to live up to the stated expectation of the university community with regard to these standards. (Please see the "Academics (p. 9)" section of this catalog for details relating to the Honor Code and System.)

Information Technology

The Division of Information Technology (it.vt.edu (http://it.vt.edu)) supports the university's computing and communications needs by providing integrated networks for data and voice communications, and services to meet Virginia Tech's instructional technology, enterprise-scale administrative processing, software procurement and support, research computing, and IT support needs. The 4help.vt.edu (http://4help.vt.edu) portal is the starting point for IT support, connecting users with direct support as well as to guides on specific tools and services.

The data network provides rapid access to cloud services, email, class materials, library databases, and the internet for every resident in university housing. Wireless access (WiFi) is available in all academic and administrative spaces across campus, as well as in many outdoor spaces. WiFi facilitates mobility across the campus and, in conjunction with the university computer requirement for hardware and software, is essential to improve the effectiveness of teaching and learning.

Virginia Tech is committed to using information technology to enhance teaching and learning and works to ensure that members of our teaching faculty have the ability to use information technology effectively. We provide continuing opportunities to learn about and incorporate both established and emerging technologies to enhance learning outcomes for students through the services provided at tlos.vt.edu (http://tlos.vt.edu). The division supports learning through our learning management system, online course evaluations, accessibility and professional development training, and support for videoconferencing and recorded media. The

required undergraduate student software bundle and other instruction-related software are offered at favorable pricing to students.

Direct IT support is provided to students through the 24x7 help resource, 4Help (4help.vt.edu (http://4help.vt.edu)). Classes and tutorials on software and many other skills are available on demand through LinkedIn Learning (linkedinlearning.vt.edu (http://linkedinlearning.vt.edu)). Computer labs offer additional options for collaboration and for access to highly specialized software. Each student is provided an email account and access to online tools from Google and Microsoft.

OneCampus (onecampus.vt.edu (http://onecampus.vt.edu)) provides secure access to personal information, including course materials, individual contact information, and billing and account information. On all platforms, security is overseen by the IT Security Office, and is protected through strong password, access, and identity management protocols, which are incorporated into the development of new applications.

Information Technology facilitates undergraduate, graduate, and faculty research through high performance computing, machine learning, acquisition of specialized research software, and collaborative research, as well as through ongoing professional development support.

For more on the Division of Information Technology, visit our website at it.vt.edu (http://it.vt.edu).

Living and Dining On-Campus

Housing and Residence Life

Virginia Tech's Housing and Residence Life operates 47 on-campus residence halls housing more than 9,300 residents. Our goal is to provide inclusive communities, foster a culture of learning, offer safe, clean, well-maintained living environments, and provide exceptional service.

A residence hall is more than just a place to sleep. The on-campus experience is enriched by the initiatives and engagement of our resident student staff and our professional and para-professional staff who live in the residence halls. We have three faculty principals living within residential colleges and many other faculty involved in the residential colleges and other living-learning communities.

To support such a dynamic environment, HRL has a complete facilities operation that includes maintenance, housekeeping, lock shop, renovations, fire and safety compliance, and warehousing. Occupancy management oversees assignments and contracting, resident communications, and general services.

All first-year students live on campus unless they fall into one of the following categories: those living with parents or other close relatives, those who are married and living with their spouses, veterans of at least six months of military service, or those who are at least 21 years old. Written requests for exceptions to this policy should be directed to Housing and Residence Life in 144 New Hall West, (0428).

Campus housing is also available, but not guaranteed, for other students. Transfer and graduate/professional students may request housing through an online wait list. A lottery-style housing application process is held each spring to allocate residential space to returning undergraduate students who wish to live on campus.

Housing and Residence Life | 540-231-6205 | housing.vt.edu (http://www.housing.vt.edu) | housing@vt.edu

Virginia Tech Off-Campus Housing

Virginia Tech Off-Campus Housing (VTOCH) provides students with resources, programs, and services to assist with their off-campus housing needs including a comprehensive searchable online database. a wonderful resource to begin. VTOCH maintains information on local apartments, realtors, transportation, and issues affecting renters today. VTOCH hosts two housing fairs each year so students can get up close and personal with rental options and roommate fairs so students can make connections with others to share living expenses.On the VTOCH website, users can find detailed information about people looking for or offering housing, ways to research housing options, roommates, furniture for sale, or ride requests. VTOCH also provides detailed information about apartment and realty companies in the Blacksburg area.

Twice each year, in the fall and in the spring, VTOCH hosts the Virginia Tech Off-Campus Housing Fair, where students, faculty, staff, and community members are able to interact with local property managers to view options for the following academic year. Additionally, other important housing-related companies will be in attendance, so guests can have conversations about their rights and responsibilities as tenants, renters insurance, utilities, and town relations. If you plan to move off-campus or just wants to see what your options are, plan to attend this once-a-semester free event.

Virginia Tech Off-Campus Housing | 540-231-3466 | www.campuslife.vt.edu/vtoch/ (http://www.campuslife.vt.edu/vtoch/) | vtoch@vt.edu

Dining Services

Virginia Tech has built a reputation for outstanding dining. Our dining program remains at the leading edge of national trends and maintains a tradition of award-winning events, programs, venues, and service. Students report high overall satisfaction and appreciate the variety of dining options available on campus. Recent customer comments such as "I brag about our food service to my friends and family" illustrate that Virginia Tech students share our pride in the dining program. Extensive online information on nutrition, special diets, and food allergies helps students plan their eating.

With more than 19,000 dining plan holders, Dining Services serves approximately 7.5 million meals per year, with total on-campus sales of $65 million annually.

Numerous dining options are available for both on-campus and off-campus students, as well as for faculty, staff, and campus visitors. All on-campus residents choose an individual Major, Mega, or Premium Flex Plan. Off-campus students may select one of six individual dining plans or participate in the Dining Dollars program. More than 11,000 off-campus students opt to have a dining plan each year.

Dining at Virginia Tech is anything but traditional. The award-winning dining program specializes in preparing diverse menus in innovative, exciting venues:

- **Au Bon Pain** operates dining venues in three campus locations.
  - Au Bon Pain in the Squires Food Court at Squires Student Center serves distinctive bakery items, upscale sandwiches, and signature soups.
  - Au Bon Pain at the Graduate Life Center serves many of the same bakery and sandwich options, as well as grab-n-go items, as the cafe in Squires Student Center. This location serves students living and studying in the Graduate Life Center.

    - Au Bon Pain at Goodwin Hall offers students on the academic side of campus a dining option that serves many of the same items as the location in Squires Student Center.
- **Burger '37** in the Squires Food Court at Squires Student Center offers gourmet beef, turkey, and vegetarian burgers, hand-cut fries, and classic shakes.
- **D2** at Dietrick Hall takes traditional dining to the next level by combining all-you-care-to-eat dining with the variety of an international marketplace and includes a shop dedicated to gluten-free, vegetarian, and vegan specialties.
- **Deet's Place** at Dietrick Hall is a gourmet coffee, ice cream, and pastry shop, complete with award-winning coffee beans roasted in-house.
- **DXpress** at Dietrick Hall is perfect for a quick snack on the run, such as biscuits, burgers, and pizza by the slice, and is open until 2:00a.m. for late-night options.
- **Hokie Grill & Co.** at Owens Hall features national brands Chick-fil-A, Pizza Hut, and Dunkin' Donuts, in addition to Blue Ridge Barbecue, grab-n-go sandwiches, snacks, salad, and fruit bar.
- **Owens Food Court** at Owens Hall consists of 12 specialty shops serving international and American favorites, including carved-to-order meats, a soup and salad bar, burgers, pastas, Philly cheese steaks, tacos, and a venue that serves exclusively local, organic, or sustainably produced foods.
- **Turner Place** at Lavery Hall offers a variety of convenient options to the academic side of campus. It houses franchises for Jamba Juice, Bruegger's Bagels, and Qdoba Mexican Grill alongside five upscale original venues serving sushi, crepes, gelato, teppanyaki, southern steakhouse fare, sourdough pizza, custom salads, and much more.
- **Vet Med Cafe** at the Virginia-Maryland Regional College of Veterinary Medicine on Duck Pond Drive and offers breakfast and lunch, Monday through Friday. Breakfast features breakfast bagel sandwiches and hot oatmeal, and lunch offers a daily chef special as well as grilled fish tacos and more.
- **West End Market** at Cochrane Hall features wood oven-baked pizzas, wraps, grilled steaks, seafood, homemade pastas, made-from-scratch soups, freshly baked pastries and breads, and more - all prepared right before your eyes.

Dining Services | 540-231-3933 | www.dining.vt.edu (http://www.dining.vt.edu) | dining@vt.edu

Location

The main campus is located in Blacksburg, Virginia, about 38 miles southwest of Roanoke, Virginia. To reach the campus from Interstate 81, take Exit 118-B (Christiansburg) onto U.S. Rt. 460 West. To reach the Visitor and Undergraduate Admissions Center, continue on U.S. 460 for 8.5 miles to the Prices Fork Road exit for "Downtown." Turn right at the first traffic light on Prices Fork Road and then take an immediate right and up the drive to the center.

Detailed Directions to Virginia Tech and Campus Map (https://vt.edu/maps.html)

Multicultural Academic Opportunities Program

The Multicultural Academic Opportunities Program (MAOP), founded in 1993 is an academic success community founded upon the principles of self-efficacy, mentoring, and peer support. Central to the goal of MAOP is the promotion of diversification within the student body of Virginia Tech. Through partnerships with various academic colleges and departments at Virginia Tech, other colleges and universities, governmental entities, and various organizations, MAOP participants are supported with academic guidance, social and emotional support, and financial support.

The MAOP community is open to all students who demonstrate a clear commitment to the pursuit of academic excellence and are interested in the promotion of diversity in an ever global community. MAOP provides opportunities for both undergraduate and graduate students through scholarships, tuition/assistantship support, academic workshops, and undergraduate research opportunities.

Web: http://www.maop.vt.edu
Phone: (540) 231-5023

Parking Regulations

All vehicles, including motorcycles and scooters, parked on the Virginia Tech campus must be registered with the Parking Services Office and must display a university parking permit. Yearly, semester, summer, and daily parking permits are available and an appropriate fee is charged for each permit. Visitors are required to display a visitor permit, which is available at the Virginia Tech Visitor Information Center. For more information about parking or to request a parking regulations handbook, visit www.parking.vt.edu (http://www.parking.vt.edu) or call (540) 231-3200.

Alternative Transportation

The Alternative Transportation Program offers several options for commuter students to get to class without the hassles of parking permits and searching for parking spaces through the Commuter Alternatives Program (CAP).

CAP has two programs to fit your commuting needs.

- Carpool Program: Carpooling saves you money on parking and gas, and it's the closest thing you can get to **reserved parking** on campus.
- BB&W is available to commuter students who use alternative transportation methods as their primary means of commuting to campus. Examples include riding the Blacksburg Transit or SmartWay buses, bicycling, and walking. By registering for BB&W, you will receive 15 half price daily parking passes per semester.

Bicycles can be registered for free through Parking Services at www.parking.vt.edu (http://www.parking.vt.edu).

For more information about commuter alternatives visit www.tcs.vt.edu/alternative (http://www.tcs.vt.edu/alternative/) or call (540) 231-0248.

ROTC Program

The Reserve Officer Training Corps Programs conducted at Virginia Tech are available to cadets and are offered by the Army, Navy/Marine Corps, and the Air Force. All students participating in ROTC are required to be members of the Corps of Cadets. Details about courses offered, as well as available scholarships and stipends, can be found in the department listings under the College of Liberal Arts and Human Sciences; ROTC (Army), ROTC (Navy/Marine Corps), and ROTC (Air Force). Upon successful graduation from Virginia Tech and completion of the ROTC program, the student is commissioned as an officer in either an active or reserve component of the Armed Forces. The total ROTC credits applied toward degree requirements varies by major and ranges from four

to 24. All credits count as free electives. Consult your course advisor for information on ROTC credits, which may be used within your major.

Students interested in additional details should contact the professor of military science for Army ROTC, the professor of naval science for Naval/Marine Corps ROTC, or the professor of aerospace studies for the Air Force ROTC program.

General Rules Governing the Cadet Lifestyle

All Virginia Tech students are eligible to join the Corps of Cadets and participate in the cadet lifestyle. Cadet student status is a prerequisite for participation in any of the ROTC programs. Students desiring to be a cadet, but not in ROTC are enrolled in the Citizen-Leader Track, also known as the VPI Battalion. VPI Battalion cadets live in the same cadet dorms, wear the same uniforms, and hold the same leadership positions, but go into private and public sector careers upon graduation.

Physical Standards: The Department of Defense has prescribed physical standards for formal enrollment in the ROTC programs. Cadets not physically qualified for an ROTC program may remain in cadet status as members of the Corps of Cadets but must maintain minimum physical standards for the Citizen-Leader Track.

Cadet Regulations: Cadets are expected to adhere to the Cadet Honor Code and abide by all cadet regulations, directives, policies, and procedures of the Corps, as well as the rules governing civilian students.

The following summary gives the prospective cadet an understanding of the nature of his or her obligation as a cadet:

- Cadet officers and non-commissioned officers are responsible to university authorities for the cadets under their supervision and are given the authority to discharge their responsibilities.
- Cadet residence halls are coeducational with controlled visiting privileges for non-residents and mandatory quiet study periods.
- Alcoholic beverages are prohibited in the cadet residence halls.
- Cadets are required to wear the cadet uniform to classes and cadet functions.
- Cadets are required to live in a designated cadet residence hall unless married and living with a spouse.
- Second-semester freshmen and upperclassmen in the corps may request a change to civilian status at any time. First-semester new cadets may not leave the corps and change to civilian status without penalty until the last day to drop a class (after six weeks of class). All students are encouraged to make status changes (from cadet to civilian lifestyle or vice versa) in conjunction with the beginning or end of an academic semester.

See Academics (p. 9) section for details on the ROTC course credits that apply toward degrees.

For Additional Information:

Commandant of Cadets
Lane Hall, Room 141
280 Alumni Mall
Virginia Tech
Blacksburg, VA 24061
(540) 231-6413
corps@vt.edu

Air Force ROTC
Military Building, Room 228
320 Stanger Street
Virginia Tech
Blacksburg, VA 24061
(540) 231-6404
usaf@vt.edu

Army ROTC
Military Building, Room 228
320 Stanger Street
Virginia Tech
Blacksburg, VA 24061
(540) 231-6401
rotc@vt.edu

Naval/Marine Corps ROTC
121 Lane Hall, Room 241
280 Alumni Mall
Virginia Tech
Blacksburg, VA 24061
(540) 231-7883
usnavy@vt.edu

Services for Students with Disabilities

Services for Students with Disabilities (SSD) serves students who have or think they may have disabilities. The department receives and reviews all student requests for reasonable accommodations, or modifications and adjustments based on disability status, to University programs including academic programs, housing, study abroad, and campus life. SSD partners with Student Affairs and campus stakeholders to ensure students with disabilities are connected to resources necessary for equal participation and access in University programs. SSD also provides academic coaching, peer mentoring services, and a scholarship for students with disabilities. Students who think they may have a disability are encouraged to contact SSD to learn more about eligibility requirements and referrals for further inquiry. Whether it's a question about sign-language interpretation, reasonable accommodations, or obtaining an emotional support animal, SSD is available to help students transition to and actively participate in University life. Contact us by phone, email, or stop by and visit us in the office.

Services for Students with Disabilities
Lavery Hall, Suite 310
430 Old Turner St
Blacksburg, VA 24061

ssd@vt.edu
540-231-3788

ADA and University Policy

In compliance with Section 504 of the Rehabilitation Act of 1973, the Americans with Disabilities Act (ADA) of 1990, and with the ADA Amendments Act of 2008, Virginia Tech is committed to ensuring that all qualified students with disabilities have the opportunity to pursue a postsecondary education without barriers to instruction and services. Under Policy Memorandum 178 and university Policy 4075, the university has given authority to Services for Students with Disabilities (SSD) to interpret disability documentation, determine the existence of a disability, and determine appropriate accommodations in this university setting. Academic accommodations, as determined by SSD, serve to "level the playing field" by removing barriers between students with disabilities and students who do not have a documented disability.

Student Affairs

Student Affairs at Virginia Tech is committed to the growth, development, and achievement of students at Virginia Tech. This organization works closely with academic colleagues to support students as they learn to be successful and effective leaders in the emerging global community. The mission of the Student Affairs is to promote student learning, life skills, and personal growth through a strong focus on holistic student development and collaborative partnerships that deliver superior service to, and care for, students in the spirit of Ut Prosim.

We want students to have an exceptional college experience at Virginia Tech, and our excellent academic programs are a great start. Recognizing that learning happens both in and out of the classroom, Student Affairs facilitates experiences and offers resources students need to graduate as successful, educated, and reflective individuals. Through Student Affairs programs, events, and services, students can hone their skills as responsible leaders, discover and pursue promising careers, develop habits for healthy and fulfilling lives, and make a tangible, positive impact on the communities to which they belong.

Student Affairs | http://www.students.vt.edu/ | 540-231-6272 | studentaffairs@vt.edu

Aspirations for Student Learning

Our philosophy is grounded in the Aspirations for Student Learning. The five Aspirations for Student Learning are our best hopes for and expectations of our students. Embracing these Aspirations helps Virginia Tech students find and define themselves through intentional reflection on all they are learning.

- Commit to unwavering **curiosity**
  Virginia Tech students will be inspired to lead lives of curiosity, embracing a lifelong commitment to intellectual development.
- Pursue **self-understanding** and **integrity**
  Virginia Tech students will form a set of affirmative values and develop the self-understanding to integrate these values into their decision-making.
- Practice **civility**
  Virginia Tech students will understand and commit to civility as a way of life in their interactions with others.
- Prepare for a life of **courageous leadership**
  Virginia Tech students will be courageous leaders who serve as change agents and make the world more humane and just.
- Embrace **Ut Prosim** as a way of life
  Virginia Tech students will enrich their lives through service to others.

ExperienceVT

Student Affairs helps students explore, practice, and live the Aspirations for Student Learning by offering opportunities they might pursue while at Virginia Tech—from internships, career fairs, and engagement in student organizations, to intramural sports, leadership development, and everything in between. Your engagement with activities outside the classroom will make you an accomplished, marketable, and self-aware community citizen, exhibiting transferable skills valued by employers. By attending events and programs, taking part in clubs and organizations, reflecting on your experiences, and tracking your progress, Virginia Tech students can capture the pivotal moments in their lives as Hokies.

This complete list of Student Affairs departments with direct links is available online at students.vt.edu (http://www.students.vt.edu).

- Advancement
- Assessment and Professional Development
- Communications
- Cook Counseling Center
- Corps of Cadets
- Cranwell International Center
- Cultural and Community Centers
- Dean of Students
- Dining Services
- Family Relations
- Finance
- Fraternity and Sorority Life
- Hokie Wellness
- Housing and Residence Life
- Human Resources
- Information Technology
- Learning Partnerships
- New Student and Family Programs
- Recreational Sports
- Schiffert Health Center
- Services for Students with Disabilities
- Student Conduct
- Student Engagement and Campus Life
- VT Engage

A detailed statement of the rights and responsibilities of students is contained in the University Policies for Student Life.

Student Engagement and Campus Life

Through Student Engagement and Campus Life, you can get involved with student organizations, arts, events and recreation, and student employment. This department, within the Division of Student Affairs, uplifts the#student experience by cultivating affirming environments, promoting holistic well-being, and providing#exceptional#services.

Student Engagement and Campus Life operates the three student centers on campus, as well as the War Memorial Chapel, Owens Ballroom, Breakzone recreation center, and the Perspective Art Gallery. The department also facilitates a number of campus services like Virginia Tech Off-Campus Housing, venue reservations and production services, , a US Passport Office, and more.

The administrative offices are located on the second floor of Squires Student Center in room 225. The office is open from 8a.m. to 5p.m. Monday through Friday. Please contact us for any information regarding Student Engagement and Campus Life.

Student Engagement and Campus Life | 540-231-5431 | campuslife.vt.edu (http://www.campuslife.vt.edu) | campuslife@vt.edu

Campus Events: From large scale events and concerts to small group workshops and gatherings, Student Engagement and Campus Life is dedicated to helping students explore their interests and meet friends through its robust experience offerings. Visit gobblerconnect.vt.edu/events (http://gobblerconnect.vt.edu/events/) to see what's happening today at Virginia Tech.

Event Services facilitates and enhances programming for the Virginia Tech community by assisting and consulting in the campus reservation

processes featured on-campus. The Event Services Office fosters an educational environment that provides student organization members and departmental representatives with venue reservations, event scheduling, information on liability and risk management issues, standard procedure and protocol, and referrals to Production Services.

Event Services
221 Squires Student Center
Phone: (540) 231-5005
E-mail: eventservices@vt.edu
Web: campuslife.vt.edu/eventservices (http://www.campuslife.vt.edu/eventservices/)

The Squires Information Desk is staffed with knowledgeable student employees who are ready to answer questions about your student centers, student activities, the university, and the surrounding community. The information desk also operates the campus Lost and Found.

The Squires Information Desk
1st floor Squires lobby
Phone: (540) 231-6906
Web: (Lost and Found): campuslife.v2.crowdfind.com/public/#/squires/items/ (https://campuslife.v2.crowdfind.com/public/#/squires/items/)

The Perspective Gallery presents art exhibitions by diverse artists working in a variety of media and styles. Visitors can view work of student, local and regional artists, nationally recognized artists, and artisans from around the world. Receptions and special events allow the public to meet and talk with the artists. Perspective Gallery is located on the second floor of Squires Student Center. Admission is always free. You can also enjoy works in the permanent collection, located throughout the public areas in Squires and Johnston Student Centers and the Graduate Life Center.

Perspective Gallery
2nd floor Squires Student Center
Phone: (540) 231-4053
Web: campuslife.vt.edu/perspectivegallery/ (http://www.campuslife.vt.edu/perspectivegallery/)

Production Services provides sound and lighting support, campus. We are equipped to deliver professional quality support to events.

Production Services
128 Squires Student Center
Phone: (540) 231-3499
Web: campuslife.vt.edu/productionservices (https://campuslife.vt.edu/secl_services/Production_Services.html)

The Student Engagement and Campus Life Ticket Office is the major online ticket distribution center for events other than athletics at Virginia Tech and Moss Arts Center events. The office supports ticket sales for theatrical and musical performances, concerts, lectures, and movies.

Student Engagement and Campus Life Ticket Office
Phone: (540) 231-5615 or 800-843-0332
Web: campuslife.vt.edu/tickets (http://www.campuslife.vt.edu/tickets/)

Virginia Tech Off-Campus Housing (VTOCH), provides students with resources and support to assist with their off-campus housing needs including a comprehensive searchable online database. VTOCH maintains information on local apartments, realtors, transportation, and issues affecting renters today. The office hosts two housing fairs each year so students can meet and ask questions of local property managers.

Virginia Tech Off-Campus Housing
E-mail: vtoch@vt.edu
Web: offcampus.vt.edu (http://offcampus.vt.edu/)

The Squires US Passport Office is a certified U.S. Department of State as a Passport Acceptance Facility located in Blacksburg, VA, on Virginia Tech's campus. Our site offers the products and services needed for a first-time passport and renewal passport applications. Visit us on the first floor of Squires Student Center. Our services are offered for both the Virginia Tech community and the public.

Squires US Passport Office
Squires Student Center, 1st Floor
E-mail: seclpassports@vt.edu
Web: campuslife.vt.edu/passports (http://campuslife.vt.edu/passports/)

The War Memorial Chapel stands prominently at the end of the Drillfield. It is the only Chapel on campus and provides a nondenominational place of solitude and meditation for all. It is host to religious services, weddings, baptisms, prayer vigils, memorial services, initiations, military commissioning, music recitals, student vocal and ministry groups, concerts, lectures, individual prayer and meditation, and bible study.

War Memorial Chapel
Phone: (540) 231-6240

Student Clubs and Organizations/GobblerConnect

Student Organizations: There are more than 800 registered student organizations at Virginia Tech. spanning a wide variety of academic and special interests. All Virginia Tech students are encouraged to find an organization that matches their interests and passions. By using GobblerConnect (gobblerconnect.vt.edu (http://www.undergradcatalog.registrar.vt.edu/1617/gobblerconnect.vt.edu)), you can search student organizations to find your community on campus.

Gobblerfest, Gobblerfair, and GobblerMarket: Students have several opportunities to meet campus student organizations in-person at our series of involvement fairs throughout the year. Gobblerfest kicks off the year on the Drillfield during Welcome Week; Gobblerfair is an indoor winter fair, and GobblerMarkets pop up throughout the year for a more in-depth, cozy environment.

The Source is the one-stop-shop for all student organizations! In The Source (located in the Breakzone) student organization members can work on a variety of DIY projects like painted banners, balloon arrangements, and buttons and stickers to promote your organization. Our space is available to student organization members on a first come, first-serve basis for committee meetings or to ask our informed staff about student organization best practices and resources.

Students who aren't quite sure where to start can lean on The Source's Engagement Ambassadors who would love to talk through the possibilities. Simply submit an involvement questionnaire (https://gobblerconnect.vt.edu/submitter/form/start/487016/) about your interests and goals and they'll connect you with opportunities and discuss the process for getting involved in a student organization or other experiences.

The Source | thesource@vt.edu | campuslife.vt.edu/thesource (https://campuslife.vt.edu/Student_Orgs/the_source.html) | Social Media: @thesourcevt

Student Centers

Squires (located off Alumni Mall) and **Johnston Student Centers** (located behind Burruss Hall) are hubs of activity for the university community. They serve as formal and informal meeting places for students, student organizations, and the larger university community. Facilities include meeting rooms, conference rooms, a ballroom, and theaters. Plenty of comfortable space welcomes students. Many departments call Squires Student Center home. We house the Intercultural Engagement Center, New Student and Family Programs, the music department, student media, student organization offices, VetZone, a non-denominational meditation space, and numerous cultural and community centers. Students, faculty, staff, and guests are free to use Squires or Johnston to meet with friends, study, attend activities and events, or just hang out.

Squires Student Center Information Desk | 1st Floor Squires Lobby | (540) 231-6906
Johnston Student Center Information Desk | 2nd Floor Johnston | (540) 231-5266

The Graduate Life Center at Donaldson Brown (located on Otey Street, across from Squires) is an innovative living-learning facility that supports Virginia Tech's goals for graduate education. The GLC features plenty of study space, a coffee shop, an auditorium, and a multipurpose conference room.

GLC Information Desk | 1st floor GLC lobby | 540- 231-0413

The War Memorial Chapel stands prominently at the end of the Drillfield. It is the only Chapel on campus and provides a nondenominational place of solitude and meditation for all. It is host to religious services, weddings, baptisms, prayer vigils, memorial services, initiations, military commissioning, music recitals, student vocal and ministry groups, concerts, lectures, individual prayer and meditation, and bible study.

War Memorial Chapel | 540-231-6240

Event Planning
221 Squires Student Center
Phone: (540) 231-5005
E-mail: eventplanning@vt.edu
Web: www.campuslife.vt.edu/eventplanning/index.html (http://www.campuslife.vt.edu/eventplanning/)

Recreation

Breakzone is the place to go to relieve the stress of classes and tests. Breakzone sponsors competitive leagues, weekly bingo and trivia nights, and open play in a variety of activities. An expanded line-up includes pool tables, bowling lanes, table tennis, foosball, and video games. Students, faculty, staff, and guests can enjoy testing their skills while relaxing with friends in an upbeat environment.

Breakzone
117 Squires Student Center
Phone: (540) 231-4476
Web: campuslife.vt.edu/breakzone (http://www.campuslife.vt.edu/breakzone%20/)

Student Employment

Student Engagement and Campus Life offers students the opportunity to work in a team-oriented environment. We take pride in our customer experience and welcome students interested in helping us execute our mission. Our student employees are treated and valued as key members of our team, and we are committed to their development and advancement through leadership and career skills training.

Student Employment
225 Squires Student Center
Phone: (540) 231-5431
Web: campuslife.vt.edu/studentemployment (http://www.campuslife.vt.edu/employment/students/)

Student Health Services and Insurance

University Student Health Services

University Student Health Services provides general ambulatory health care to students throughout the year. Students who have paid their health fee (included as part of the university's comprehensive fee) and submitted a health history form are eligible for services. A team of physicians, nurse practitioners, physician assistants, certified college health nurses, and licensed practical nurses manages most common illnesses and injuries. X-ray, laboratory, and pharmacy services are available on site.

Student Health History

Each student entering Virginia Tech must furnish a health history form, completed by a home physician, for the University Student Health Services. The form will be available online to applicants who accept the offer of admission. Failure to meet Health Services standards may result in dismissal from the university. Information is available at www.healthcenter.vt.edu (http://www.healthcenter.vt.edu).

Student Medical Insurance Coverage

The university has contracted with a health insurance carrier to offer group health coverage for full-time students at Virginia Tech. For details on coverage and specific benefits, please contact the Student Medical Insurance office at 540/ 231-6226 or visit http://risk.controller.vt.edu/studentmedicalinsurance.html.

Health insurance is mandatory for international students with F-1 or J-1 visas and all Virginia Tech Carilion School of Medicine and College of Veterinary Medicine students. All students with a mandatory insurance requirement must purchase the university-sponsored plan or another health insurance plan meeting or exceeding the University outlined minimum coverage levels. Students should review their insurance policies and complete the online waiver form found at http://risk.controller.vt.edu/studentmedicalinsurance.html. Once the student submits the waiver form, the university will review the documentation to determine if the insurance coverage meets the outlined minimum requirements.

Global Travel Insurance & Emergency Assistance

Under University Policy 1070, http://www.policies.vt.edu/1070.pdf, all Virginia Tech students participating in university supported global travel are required to carry international medical and emergency assistance insurance. To meet this requirement, the university has contracted with an insurance provider CISI.

Some of the benefits of the Cultural Insurance Services International (CISI) policy include:

- Security & Natural Disaster Evacuation
- Repatriation
- Emergency Medical expenses, medical evacuation, & medical reunion

Those traveling internationally in a group for a formal education and study abroad program should refer to the Virginia Tech Global Education website at https://www.globaleducation.vt.edu for insurance requirements.

Those traveling internationally on Virginia Tech business, not in a study abroad program, should refer to Virginia Tech Risk Management website at http://risk.controller.vt.edu/vi/international.html.

University at a Glance

Dedicated to its motto, Ut Prosim (That I May Serve), Virginia Tech pushes the boundaries of knowledge by taking a hands-on, transdisciplinary approach to preparing scholars to be leaders and problem-solvers.

A comprehensive land-grant institution that enhances the quality of life in Virginia and throughout the world, Virginia Tech is an inclusive community dedicated to knowledge, discovery, and creativity. Virginia Tech offers the widest range of degree choices in Virginia to more than 37,000 undergraduate, graduate, and professional students on all its campuses.

Virginia Tech has a significant presence across Virginia, including numerous Extension offices and research centers. In Northern Virginia, the university is developing a 1 million-square-foot Innovation Campus that will become a global center of talent production and technology excellence. In Roanoke, the Fralin Biomedical Research Institute at VTC and the Virginia Tech Carilion School of Medicine are a part of the emerging Health Sciences and Technology Campus. The main campus is in Blacksburg, Virginia, while the university's international presence is anchored by the Steger Center for International Scholarship in Riva San Vitale, Switzerland. Other sites are in Newport News, Richmond, and Abingdon.

Offering more than 280 undergraduate and graduate degree programs, Virginia Tech has eight undergraduate colleges, a school of medicine, a veterinary medicine college, Graduate School, and Honors College. Inside and outside of the classroom, in living-learning communities, and in its Corps of Cadets, and in collaboration across academic disciplines, Virginia Tech students engage in experiential learning.

In Virginia Tech's transdisciplinary communities called Destination Areas, scholars seek to address complex global challenges that cross traditional academic boundaries. Taking students to the next level by helping them solve real-world problems, Tech professors have a reputation for imagining the next great thing from self-driving cars to energy-conscious homes and then making it happen.

A leading global research institution, Virginia Tech conducts more than $550 million in research each year (the FY20 total was $556 million). The university boasts world-class research institutes and facilities such as the Smart Road transportation research testbed, and the Cube, a four-story theater and laboratory in the Moss Arts Center. The Link + License + Launch team, a one-stop shop for industry partners from discovery to market, is dedicated to streamlining all aspects of corporate partnerships, from research collaborations to corporate giving to technology commercialization and startups.

Guided by its Principles of Community, the university is dedicated to increasing access, inclusion, and diversity in order to create a community that nurtures learning and growth for all of its members.

The desire to serve is deeply ingrained in Virginia Tech's learning, discovery, and engagement. More than a motto, Ut Prosim is a value system that guides students' decisions and helps mold them into responsible citizens of the world.

University Exemplary Departments

University Exemplary Department Awards recognize the work of departments that maintain, through collaborative efforts of dedicated colleagues, exemplary teaching and learning environments for students and faculty.

University Facilities

Virginia Tech has more than 235 campus buildings, research laboratories, an airport, a 2,600-acre main campus in Blacksburg, a 1,800-acre research farm in Montgomery County, and facilities across the commonwealth.

Among the university's major facilities in Blacksburg are: Carol M. Newman Library, with more than 2.3 million volumes; the Moss Arts Center, home of the Center for the Arts at Virginia Tech professional presenting program; The Inn at Virginia Tech and Skelton Conference Center, which offers conference space and 147 hotel rooms and suites; Cassell Coliseum (seating 10,000); and Lane Stadium (seating more than 66,000). Adjacent to campus is the Virginia Tech Corporate Research Center, which employs more than 3,000 and offers businesses the opportunity to establish close working relationships with the university.

Major facilities outside of Blacksburg include the Innovation Campus in Northern Virginia, now under development; the Steger Center for International Scholarship and Architecture in Switzerland; the Virginia Tech Northern Virginia Center in Falls Church; the Hotel Roanoke & Conference Center; public radio station WVTF, which covers a large part of Virginia; the Marion duPont Scott Equine Medical Center in Leesburg; Virginia Tech Research Center - Arlington; the Washington-Alexandria Center of the College of Architecture and Urban Studies; the Virginia Tech Carilion School of Medicine and Fralin Biomedical Research Institute in Roanoke; Tech Center Research Park in Newport News, Virginia; 11 agricultural experiment stations; and six 4-H centers.

University Libraries

A member of the prestigious Association of Research Libraries, the University Libraries consist of the Carol M. Newman Library and three branches: Art and Architecture, Veterinary Medicine, and the Northern Virginia Resource Center located in Falls Church, Virginia. Their online services are available 24/7.

The libraries offer services and resources to support students in their work every step of the way. From visiting the information services desk on the second floor for help with a research project, to using our 3D printing studio (http://designstudio.lib.vt.edu/) for course projects, to simply using our spaces for quiet our collaborative work, students can find numerous resources at the libraries.

Newman Library is home to many hands-on spaces that allow experiential learning, such as Fusion Studio (http://fusionstudio.lib.vt.edu/) for longer term collaborative projects. Students can also seek help with writing papers and other projects at the English department's Writing Center, or assistance preparing for presentations at the communication department's CommLab, both on the second floor. Other library studios include Media Design (https://www.mediastudio.lib.vt.edu), Data Visualization (https://www.datavizstudio.lib.vt.edu), Data Transformation (https://

www.dtstudio.lib.vt.edu), and Virtual Environments (https://www.virtualstudio.lib.vt.edu). The Libraries' Digital Humanities and Social Sciences program – Athenaeum (https://www.lib.vt.edu/spaces/athenaeum.html) provides support to courses and research projects in these disciplinary areas.

Help can be found on our homepage (https://lib.vt.edu/), and many resources, including our Ask A Librarian chat (http://www.lib.vt.edu/help/ask.html), online collections, and subject research guides (http://guides.lib.vt.edu/), can be used from anywhere on or off campus, without stepping foot in our buildings.

In each of the libraries, there is a Circulation/Reference desk staffed by people who can help you locate and use resources. Each college and academic department also has a librarian who is a subject expert (http://www.lib.vt.edu/instruct/clprg.html) and can help you find relevant research, suggest journals, or point you in the direction of resources for your area of study.

Special Collections, located on the first floor of Newman Library, houses major research collections including the Archives of American Aerospace Exploration, the International Archive of Women in Architecture, Railroad Archives, the Culinary History Collection, and many items from the Civil War.

For users with disabilities, there is a Special Services Room in Newman Library equipped with adaptive software and hardware.

For additional information, check out www.lib.vt.edu (http://www.lib.vt.edu), come walk through our spaces, or stop by one of the help desks.

Veterans Services

The Office of Veterans Services is the primary resource for Virginia Tech veterans and their dependents. Staff work closely with the Department of Veterans Affairs to receive and process all documentation related to veteran and military student educational benefits. The Office of Veterans Services works closely with The Student Success Center to ensure veterans, military students and dependents are connected to the resources necessary for a successful transition to and through their course of study at Virginia Tech. In collaboration with The Student Success Center, students served by the Office of Veterans Services have access to tutoring, mentoring, assistance navigating the VA system, and the Veterans@VT student organization.

220 Gilbert Place, Suite 2100
Blacksburg, VA 24061
Phone: (540) 231-5815
E-mail: veteran@vt.edu
Web: www.veterans.vt.edu (http://www.veterans.vt.edu)

Minors

A

- Actuarial Science (ACSC) Minor (p. 383)
- Adaptive Brain and Behavior (ABB) Minor (p. 384)
- Advertising (ADV) Minor (p. 384)
- Africana Studies (AFST) Minor (p. 385)
- Agribusiness and Entrepreneurship (ABAE) Minor (p. 385)
- Agricultural and Applied Economics (AEMN) Minor (p. 386)
- American Indian Studies (AINS) Minor (p. 386)
- American Studies (AMS) Minor (p. 386)
- Animal and Poultry Sciences (APSC) Minor (p. 387)
- Animal and Poultry Sciences Equine (APEQ) Minor (p. 388)
- Appalachian Cultures and Environments (APCE) Minor (p. 388)
- Applied Music (AMUS) Minor (https://catalog.vt.edu/undergraduate/minors/applied-music-minor/)
- Arabic (ARBC) Minor (p. 390)
- Art History (AHST) Minor (p. 390)
- Asian Studies (ASIA) Minor (p. 390)
- Astronomy (ASTR) Minor (p. 391)

B

- Behavioral Decision Science (BDS) Minor (p. 392)
- Biodiversity Conservation (BIOD) Minor (p. 392)
- Biological Physics (BIPH) Minor (p. 393)
- Biological Sciences (BIOL) Minor (p. 394)
- Biomedical Engineering (BME) Minor (p. 394)
- Blue Planet (BLPL) Minor (p. 396)
- Business (BUSR) Minor (p. 397)
- Business Sustainability (BSUS) Minor (https://catalog.vt.edu/undergraduate/minors/business-sustainability-minor/)

C

- Chemistry (CHEM) Minor (p. 398)
- Chinese Studies (CHNS) Minor (p. 398)
- Cinema (CINE) Minor (p. 398)
- Civic Agriculture and Food Systems (CAFS) Minor (p. 399)
- Classical Languages (CLL) Minor (p. 400)
- Classical Studies (CLA) Minor (p. 400)
- Climate and Society (CLSO) Minor (p. 401)
- Commodity Market Analytics (CMAM) Minor (https://catalog.vt.edu/undergraduate/minors/commodity-market-analytics-minor/)
- Community Systems and Engagement (CSE) Minor (p. 402)
- Computer Science (CS) Minor (p. 403)
- Consumer Studies (CONS) Minor (p. 403)
- Crop & Soil Environmental Sciences (CSES) Minor (p. 403)
- Cybersecurity (CYBR) Minor (p. 404)

D

- Dairy Science (DASC) Minor (p. 405)
- Data and Decisions (DTDC) Minor (p. 405)
- Design + Technology + Creative Expression (DTCE) Minor (p. 406)
- Development and International Trade (DAIT) Minor (p. 406)
- Digital Marketing Strategy (DMS) Minor (p. 407)
- Disability Studies (DST) Minor (https://catalog.vt.edu/undergraduate/minors/disability-studies-minor/)
- Diversity and Community Engagement (DCE) Minor (p. 407)

E

- Early Childhood Development and Education Minor (ECDE) (p. 409)
- Ecological Cities (ECOC) Minor (p. 410)
- Economics (ECAS) Minor (p. 411)
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- Ecosystem for Human Well-Being (EHWB) Minor (p. 412)
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- Entrepreneurship - New Venture Growth (ENVG) Minor (p. 414)
- Environmental Economics (EECO) Minor (p. 416)
- Environmental Policy and Planning (EPP) Minor (p. 416)
- Environmental Science (ENSC) Minor (p. 416)
- Environmental, Social and Governance Analytics (ESGA) Minor (https://catalog.vt.edu/undergraduate/minors/environmental-social-governance-analytics-minor/)
- European Engagement (EURE) Minor (p. 417)
- European Studies (EUST) Minor (p. 417)
- Event & Experience Management (EEMG) Minor (p. 418)

F

- Fermentation (FRMT) Minor (https://catalog.vt.edu/undergraduate/minors/fermentation-minor/)
- Finance (FIN) Minor (p. 419)
- Food Science and Technology (FST) Minor (p. 420)
- Food, Agriculture, and Society (FAS) Minor (https://catalog.vt.edu/undergraduate/minors/food-agriculture-society-minor/)
- Forestry (FORS) Minor (p. 420)
- French (FR) Minor (p. 421)
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G

- Gender, Science and Technology (GST) Minor (p. 422)
- Geographic Information Science (GIS) Minor (p. 422)
- Geographic Information Science (GIS-G) Minor Meteorology/Geography Majors (p. 423)
- Geography (GEOG) Minor (p. 423)
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- Global Business Practices to Improve the Human Condition (GBP) Minor (p. 424)
- Global Development and Political Economy (GDPE) Minor (https://catalog.vt.edu/undergraduate/minors/global-development-political-economy-minor/)
- Global Engagement (GLBE) Minor (p. 425)
- Global Food Security and Health (GFSH) Minor (p. 426)
- Green Engineering (GREN) Minor (p. 426)

H

- Health Communication (HCOM) Minor (p. 429)
- History (HIST) Minor (p. 429)
- Honors Collaborative Discovery Minor (https://catalog.vt.edu/undergraduate/minors/honors-collaborative-discovery/)
- Horticulture (HORT) Minor (p. 431)
- Housing and Society (HOSO) Minor (p. 431)
- Human-Computer Interaction (HCI) Minor (p. 433)
- Humanities, Science and Environment (HSE) Minor (p. 434)

I

- Industrial Design (IDS) Minor (p. 434)
- Innovation (INNO) Minor (p. 435)
- Integrated Security (ISDA) Minor (p. 435)
- Integrative Health and Wellness (IHW) Minor (p. 438)
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- International Relations (IREL) Minor (p. 443)
- International Studies (IS) Minor (p. 444)
- Italian (ITAL) Minor (p. 447)

J

- Japanese Studies (JPNS) Minor (p. 448)
- Judaic Studies (JUD) Minor (p. 448)

L

- Landscape Architecture (LAR) Minor (p. 448)
- Language and Culture for the Practice of Science (LCPS) Minor (p. 449)
- Language Sciences (LNGS) Minor (p. 450)
- Latin (LAT) Minor (p. 450)
- Leadership and Service (LAS) Minor (p. 451)
- Leadership and Social Change (ILRM) Minor (p. 452)
- Leadership, Corps of Cadets (LMCC) Minor (p. 454)
- Literature (LIT) Minor (p. 456)

M

- Materials in Society (MTSC) Minor (p. 456)
- Mathematics (MATH) Minor (p. 458)
- Medicine and Society (MSOC) Minor (p. 458)
- Medieval & Early Modern Studies (MEES) Minor (p. 459)
- Meteorology (MTRG) Minor (p. 460)
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Actuarial Science (ACSC) Minor

Code	Title	Credits
Required Minor Courses		
Complete Courses from five areas of study.		
I. Probability		
STAT 4105	Theoretical Statistics	3
or STAT 4705	Probability and Statistics for Engineers	
Subtotal		3
• STAT 4714 may replace STAT 4105 or STAT 4705 if taken before the minor was declared.		
II. Finance		
FIN 3104	Introduction to Finance	3
FIN 3134	Financial Analytics	3
Subtotal		6
III. Statistics-Regression		
Select one of the following:		3
STAT 3005 & STAT 3006	Statistical Methods and Statistical Methods	
STAT 4706	Probability and Statistics for Engineers	
STAT 4214	Methods of Regression Analysis	
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
• BIT 2406 is appropriate for Pamplin College of Business Majors ONLY. Students in other programs must select from the other courses in this area.		
Subtotal		3
IV Statistics-Time Series		
STAT 4534	Applied Statistical Time Series Analysis	3
Subtotal		3
V. Economics		
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
Subtotal		6
Total Credits		**21**

Graduation Requirements

Prerequisites and Course Duplication

Some courses might have prerequisites not shown. Students are required to double-check course pre-requests, the duplicated course list, and equivalents. Please see your advisor or consult the undergraduate course catalog for more information.

Satisfactory progress:

- A minor GPA of 2.0 or higher must be attained in the courses counting towards the minor.
- A grade of B minus or better must be earned in the classes listed in sections II, III, IV, and V to be eligible for the Society of Actuaries Validation by Educational Experience.

Adaptive Brain and Behavior (ABB) Minor

Code	Title	Credits
Gateway Courses		
Select two of the following:		6
BMES 2004	Concussion Perspectives: Medical, Scientific and Societal Perspectives	
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience	
NEUR 2464	Neuroscience and Society	
Subtotal		6
Foundational Courses		
Select one of the following:		3
EDCO 2004	Healthy Relationships: Understanding Self and Others	
EDEP 2444	Motivating Yourself and Others	
HD 2004	Adulthood and Aging	
HNFE 2664	Behavioral Theory in Health Promotion	
PSYC 1004	Introductory Psychology	
Subtotal		3
ABB Minor Electives (at least one course must be at the 3000 or 4000 level)		
Select two of the following:		6
ADV 2134	Introduction to Health Communication	
HD 1004	Childhood and Adolescence	
HD 3114	Issues in Aging	
HNFE 2664	Behavioral Theory in Health Promotion	
ECON/BDS 3134	Choice and Behavior	
EDCO 2004	Healthy Relationships: Understanding Self and Others	
EDEP 2444	Motivating Yourself and Others	
HD 2004	Adulthood and Aging	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health	
NEUR 2025	Introduction to Neuroscience	
NEUR 2026	Introduction to Neuroscience	
NEUR 2464	Neuroscience and Society	
NEUR 3944	War and the Brain	
NEUR/ECON/PSYC 4454	Neuroeconomics	
PSYC 1004	Introductory Psychology	
PSYC 2034	Developmental Psychology	
PSYC 2044	Psychology of Learning	
PSYC 2064	Introduction to Neuroscience of Behavior	
PSYC 3014	Psychopathology	
PSYC 3024	Human Behaviors and Natural Environments	
PSYC 3054	Health Psychology	
PSYC 4064	Physiological Psychology	
PSYC 4074	Sensation and Perception	
PSYC 4114	Cognitive Psychology	
SOC 3714	Sociology of Aging	
SOC 4714	Sociology of Mental Illness	
STS 2154	The Life Sciences and Society	
BMES 3004	Helmet Design: Biomechanics to Health & Social Disparities in Sports	
Subtotal		6
ABB Minor Capstone Requirements		
HD 4714	Senior Capstone Seminar	3
or NEUR 3554	Neuroscience Research and Practical Experience	
or NEUR 4044	Neuroscience Senior Seminar	
or NEUR 4594	Clinical Neuroscience in Practice	
Or one of the following may substitute with ABB Advisor approval:		
XXXX 3954/4954	Study Abroad	
XXXX 4974	Independent Study	
XXXX 4984	Special Study	
XXXX 4994	Undergraduate Research	
Subtotal		3
Total Credits		**18**

Graduation Requirements

Note: For the courses attempted for this minor, students must maintain an overall minor GPA of 2.0 or better. A minimum of 18 hours is required to graduate with an Adaptive Brain and Behavior minor.

Advertising (ADV) Minor

The Advertising Minor introduces students from outside mass communication disciplines to basic principles of paid persuasive communication. The minor requires students to earn 15 credits from units within the School of Communication and 3 credits from the Marketing Department in the Pamplin College of Business. The requirements and electives are listed below. Some courses on this checksheet have prerequisites that are not part of the minor requirements. Please consult the University Course Catalog or check with your academic adviser for information about those prerequisites.

Code	Title	Credits
Required Minor Courses		
COMM 2024	Media Writing	3
MKTG 3504	Advertising	3
ADV 3004	Advertising Copywriting and Brand Storytelling	3
Subtotal		9
Elective Courses		
Select three of the following:		9
ADV 3014	Account Planning and Media Buying	

ADV 3024	Ethics and Social Responsibility in Advertising	
CMST 3064	Persuasion	
JMC 4064	Social Media Analytics	
JMC 4264	Social Media Theory and Practice	
PR 2044	Principles of Public Relations	
PR 3084	Advanced Public Relations Research Methods	
PR 4164	Public Relations Administration	
Subtotal		9
Total Credits		**18**

Graduation Requirements

The minor requires students to earn 15 credits from units within the School of Communication and 3 credits from the Marketing Department in the Pamplin College of Business. Some courses on this checksheet have prerequisites that are not part of the minor requirements.

Total Required Credits: 18

GPA Requirement: A GPA of 2.0 or higher is required in the minor.

Africana Studies (AFST) Minor

Code	Title	Credits
Required Minor Courses		
AFST 1714	Introduction to African American Studies	3
or AFST 1814	Introduction to African Studies	
AFST 4354	Topics in Africana Studies (may be taken twice under different topics)	3
Subtotal		6
Elective Courses		
Select twelve credits of the following: [1]		12
AFST/ENGL/ TA 2044	Contemporary African American Theatre	
AFST/RLCL 2144	African Religions	
AFST/RLCL/ WGS 2204	Race and Gender in Religion and Culture	
AFST/HIST 2275	African-American History (1619-1877)	
AFST/HIST 2276	African-American History (1877-present)	
AFST 2354	The Civil Rights Movement	
AFST/SOC 2454	Race and Racism	
AFST/ENGL 2644	Introduction to African-American Literature	
AFST 2734	The Black Woman in the U.S.	
AFST 2754	Sports and the Afro-American Experience	
AFST 2774	Black Aesthetics	
AFST/CINE 3444	African American Images in Film	
AFST 3454	African American Leadership for Social Change	
AFST 3984	Special Study	
AFST 4704	History of African-American Theatre	
AFST 4774	Blacks in the Performing Arts	
AFST 4974	Independent Study (variable credit)	
AFST 4994	Undergraduate Research (variable credit)	
Subtotal		12
Total Credits		**18**

[1] At least 6 credits must be 3000 level or above.

Graduation Requirements

A minimum of 18 hours is required to graduate with an Africana Studies minor. A minimum of 6 credit hours at must be taken at the 3000 level or above. A minimum GPA of 2.0 in all courses taken to fulfill the minor is required. For additional information contact: Dr. Brandy Faulkner, Africana Studies Program Director at bfaulkne@vt.edu, 514 Major Williams Hall.

Agribusiness and Entrepreneurship (ABAE) Minor

Code	Title	Credits
I - Required Introductory Courses [1]		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Subtotal		6
II - Required Core Courses		
AAEC 2434	Foundations of Agribusiness [2]	3
AAEC 3454	Small Business Management and Entrepreneurship [2]	3
AAEC 3504	Marketing Agricultural Products [2]	3
AAEC 3604	Agricultural Law	3
Subtotal		12
Elective Courses		
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
Subtotal		6
Total Credits		**24**

[1] This minor is not available to students majoring in Agribusiness, Applied Economic Management, Environmental Economics: Management & Policy, International Trade and Development or Food and Health Systems Economics.

[2] **Pre-requisites**: Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

Graduation Requirements

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Agricultural and Applied Economics (AEMN) Minor

Code	Title	Credits
I. Required Introductory Courses [1]		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Subtotal		6
II. Required Core Course		
AAEC 2434	Foundations of Agribusiness	3
or AAEC 2104	Personal Financial Planning	
Subtotal		3
III. Elective Credits		
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
Subtotal		15
Total Credits		**24**

[1] This minor is not available to students majoring in Agribusiness, Applied Economic Management, Environmental Economics: Management & Policy, International Trade and Development or Food and Health Systems Economics.

Graduation Requirements

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

American Indian Studies (AINS) Minor

The Minor in American Indian Studies requires 18 semester hours:

- the four required AINS courses (3 hours each)
- two electives (3 hours each).

At least 9 hours of credit (including those in the list of required courses) must be taken at the 3000 level or above. Normally only one Independent Study (AINS 2974 Independent Study or AINS 4974 Independent Study, or another departmental Independent Study course approved by the American Indian Studies director) will be accepted for credit. The Special Study course (AINS 4984 Special Study, or another department equivalent approved by the American Indian Studies director) may be taken more than once if the topic of each course is different. Check undergraduate catalog for prerequisites.

A minimum GPA of 2.0 in all courses taken to fulfill the minor is required.

Code	Title	Credits
Required Minor Courses		
AINS 1104	Introduction to American Indian Studies	3
AINS/ENGL 2804	Contemporary Native American Literatures	3
AINS/PSCI 3684	Indigenous Peoples and World Politics	3
AINS 4004	Topics in American Indian Studies	3
Subtotal		12
Elective Courses		
Select six hours from the list of American Indian Studies courses and/or from the list of pre-approved electives in other departments or programs:		6
American Indian Studies		
AINS/HUM 2104	Oral Traditions and Culture	
AINS 2974	Independent Study	
AINS/ENGL 3304	The Languages of Native America	
AINS 4754	Internship	
AINS 4974	Independent Study	
AINS 4994	Undergraduate Research	
Pre-approved Electives in Other Departments or Programs [1]		
AFST/SOC 2454	Race and Racism	
ART 3004	Topics in Art History (when on appropriate topic)	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
RLCL 4324	Topics in Religion and Culture (when on appropriate topic) (See AINS Director for approval)	
SOC 1014	Introduction to Social Anthropology	
SOC 2024	Sociology of Race and Ethnicity	
SOC/GEOG/ UAP 4764	International Development Policy and Planning	
Subtotal		6
Total Credits		**18**

Graduation Requirements

Minimum 18 credits to complete the minor. Twelve of the credit hours are from required courses. Students may select the additional six hours from the list of American Indian studies courses and/or from the list of pre-approved electives in other departments or programs. A minimum GPA of 2.0 in all courses taken to fulfill the minor is required.

1 Non-AINS courses may not be substituted for 1000- or 2000-level AINS courses.

American Studies (AMS) Minor

Code	Title	Credits
Required Minor Courses		
HUM 2504	Introduction to American Studies	3
HUM 4104	Explorations in Advanced Humanities Topics	3
Subtotal		6
Elective Courses		
Select at least twelve credit hours from at least two of the following four areas: [1]		12
Area I: Literature		
ENGL 2804	Contemporary Native American Literatures [2]	
ENGL 3624	Appalachian Literature	

ENGL 3654	Ethnic American Literature	
ENGL 4634	Studies in an American Author before 1900 (junior standing required) [2]	
or ENGL 4644	Studies in an American Author after 1900	
Area II: History and Politics		
HIST 1116	History of the United States	
HIST 2275	African-American History	
HIST 2276	African-American History	
HIST 3004	Colonial America	
HIST 3064		
HIST 3084	Recent America, 1917-Present	
HIST 3104		
HIST 3105	Women in U S History	
HIST 3114		
HIST 3106	Women in U S History	
HIST 3144	American Environmental History	
PSCI 1014	Introduction to United States Government and Politics	
PSCI 3255	The Politics of Race, Ethnicity and Gender	
or PSCI 3256	The Politics of Race, Ethnicity and Gender	
PSCI 3754	American Political Theory [2]	
Area III: The Arts and Communication		
HUM/RLCL 1504	Introduction to Popular Culture	
ARCH 4214	[2, 3, 4]	
APS 2404	Folk Cultures in Appalachia	
APS 2434	The Cultural Politics of Music in Appalachia	
ART 3784	European and American Art Since 1900 [2]	
ART 3884	American Art to 1914 [2]	
CINE 3514	American Cinema Genres [2]	
HUM/AINS 2104	Oral Traditions and Culture	
HUM/RLCL 3034	Theories of Popular Culture	
SOC 4114	The Sociology of Popular Music	
Area IV: Cultural Studies		
AFST 1714	Introduction to African American Studies	
AINS 1104	Introduction to American Indian Studies	
AINS 4004	Topics in American Indian Studies [3]	
APS/HUM 1704	Introduction to Appalachian Studies	
APS/HUM/AHRM/GEOG/HD/UAP 3464	Appalachian Communities [2]	
HUM 4414	Issues in Appalachian Studies [2, 3]	
LAR 4034	Evolution of the American Landscape	
RLCL 2124	Religion in American Life	
RLCL 4324	Topics in Religion and Culture [2, 3, 4]	
UAP 1024	Leadership, Service, and Public Problem Solving	
WGS 2264	Race, Class, Gender, and Sexualities	
WGS 3004	Topics in Feminism [2, 3, 4]	
Subtotal		12
Total Credits		**18**

1 No more than ONE course (3 credit hours) may be at the 1000-2000 level.
2 Please note pre-requisite(s) for this course.
3 This course may be repeated for credit when the topic varies.
4 These variable topics courses may be included in the minor when the topic is relevant to American Studies, as approved by the minor coordinator.

Graduation Requirements

Special offerings, including Independent Study, Undergraduate Research, and Study Abroad, and relevant courses in this or other departments may be used to fulfill requirements of up to six (6) credits for the minor where appropriate. Permission to count such courses must be granted by the minor coordinator. Courses taken to fulfill the requirements of the minor cannot be taken as pass/fail unless that is the only way the course is taught. Students should check the course catalogue for the latest information on course pre-requisites.

To graduate with a minor in American Studies, a student must have an over-all GPA of 2.0 and an in-minor GPA of 2.0 from all of the courses taken from the minor check-sheet.

For more information, consult the minor coordinator, Dr. Danille Christensen, 105 Major Williams Hall, dec09@vt.edu

1 No more than **one** course (3 credit hours) may be at the 1000-2000 level.
2 Please note pre-requisite(s) for this course.
3 This course may be repeated for credit when the topic varies.
4 These variable topics courses may be included in the minor when the topic is relevant to American Studies, as approved by the minor coordinator.

Animal and Poultry Sciences (APSC) Minor

Code	Title	Credits
Required Minor Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
APSC 1454	Introduction to Animal and Poultry Science (APSC 1464 co-requisite requirement is waived for minors.)	3
ALS 2304	Comparative Animal Physiology and Anatomy	4
Subtotal		7
Elective Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
A minimum of 6 credits at the 3000-4000 level must be completed.		
Select at least eleven credits from the following courses:		11
APSC 1464	Animal and Poultry Science Laboratory	
APSC 2104	Poultry Laboratory	
APSC 2114	Livestock Management and Handling	
ALS 2504	Animals in Society	
APSC 3064	Companion and Laboratory Animal Science	
ALS 3104	Animal Breeding and Genetics	

ALS 3204	Animal Nutrition and Feeding	
APSC/DASC 3134	Animal Agriculture and the Environment	
APSC/FST 3214	Principles of Meat Science	
APSC 3254	Animal Products	
ALS 3304	Physiology of Reproduction	
APSC 3334	Animal Welfare and Bioethics	
APSC 3434	Host Microbe Interactions	
APSC 3504	Poultry Science and Health	
APSC 3754	Principles of Livestock Evaluation	
APSC 3764	Livestock Merchandising	
APSC 4304	Principles and Practices of Bovine Reproduction	
APSC 4404	Commercial Poultry Enterprise Management	
APSC 4414	Beef and Sheep Production and Industry	
APSC 4444	Swine Production	
APSC 4514	Animal Growth and Development	
APSC 4774	Nutrition and the Animal Brain	
Subtotal		11
Total Credits		**18**

Graduation Requirements

1. Total credits required: A minimum of 18 credit hours, with at least 6 hours at the 3000 or 4000 level.
2. A minimum GPA of 2.0 which includes all courses taken that count toward the minor is required.
3. To remain in the minor, students must complete at least 3 credits from the listed courses each academic year.

Animal and Poultry Sciences Equine (APEQ) Minor

Code	Title	Credits
Required Minor Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
APSC 1454	Introduction to Animal and Poultry Science (APSC 1464 co-requisite requirement is waived for minors.)	3
APSC 2424	Introduction to the Equine Industry	3
Subtotal		6
Elective Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
A minimum of 6 credits at the 3000-4000 level must be completed.		
Select at least twelve credits from the following courses:		12
APSC 1464	Animal and Poultry Science Laboratory	
APSC 1524	Beginning Equitation	
APSC 2124	Horse Handling Practicum	
ALS 2304	Comparative Animal Physiology and Anatomy	
ALS 2504	Animals in Society	
APSC 2524	Intermediate Equitation	
APSC 2624	Beginning Equitation Over Fences	
APSC 2824	Equine Conformation and Biomechanics	
ALS 3104	Animal Breeding and Genetics	
ALS 3204	Animal Nutrition and Feeding	
ALS 3304	Physiology of Reproduction	
APSC 3334	Animal Welfare and Bioethics	
APSC 3524	Intermediate Equitation Over Fences	
APSC 3624	Advanced Equitation Over Fences	
APSC 3724		
APSC 3764	Livestock Merchandising	
APSC 3824	Equine Training and Marketing	
APSC 4124	Equine Health and Disease	
APSC 4204	Advanced Equine Nutrition and Feeding	
APSC 4224	Equine Exercise Physiology	
APSC 4324	Equine Reproduction and Neonatal Care	
APSC 4624	Topics in Equine Science	
APSC 4424	Horse Production and Management	
Subtotal		12
Total Credits		**18**

Graduation Requirements

1. Total credits required: A minimum of 18 hours, with at least 6 hours at the 3000 or 4000 level.
2. A minimum GPA of 2.0 which includes all courses taken that count toward the minor is required.
3. To remain in the minor, students must complete at least three credits from the listed courses each academic year.

Appalachian Cultures and Environments (APCE) Minor

Code	Title	Credits
I. Required Minor Courses		
APS/HUM 1704	Introduction to Appalachian Studies (Introduction, Pathways Concept 2 - Critical Thinking in the Humanities (IG))	3
APS/HUM 4414	Issues in Appalachian Studies (Capstone, Pathways Concept 1 - Discourse (E))	3
Subtotal		6
II. Elective Courses		
Select four courses of the following: [1]		12
Writing, Language, & Communication		
ALS 2204	Sustainable Food Systems (Pathways Concept 1 - Discourse (IG))	
ENGL 2634	Writing and Social Justice (Pathways Concept 1 - Discourse Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (E))	
HUM/AINS 2104	Oral Traditions and Culture	
TA 2404	Introduction to Applied Collaborative Techniques (Pathways Concept 1 - Discourse or Pathways Concept 6 - Critique and Practice in Design and the Arts (IG))	

ENGL/RLCL/SOC 3144	Language and Ethnicity in the United States (Pathways Concept 1 - Discourse or Pathways Concept 3 - Reasoning in the Social Sciences (IG))
APS 4034/SOC 4054	Appalachian Languages and Cultures
LAR 4034	Evolution of the American Landscape (Pathways Concept 1 - Discourse or Pathways Concept 2 - Critical Thinking in the Humanities (IG))
Sciences & Environment	
LAR 1254	Environment and Natural Systems (Pathways Concept 4 - Reasoning in the Natural Sciences or Pathways Concept 5 - Quantitative and Computational Thinking (IG))
FREC 2114	Ecology of Appalachian Forests (Pathways Concept 4 - Reasoning in the Natural Sciences (E))
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development (Pathways Concept 4 - Reasoning in the Natural Sciences (IG))
HORT 4794	Medicinal Plants and Herbs
Society & Place	
AINS 1104	Introduction to American Indian Studies (Pathways Concept 3 - Reasoning in the Social Sciences (IG))
AFST 1714	Introduction to African American Studies (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (IG))
GEOG 1116	Seeking Sustainability (Pathways Concept 3 - Reasoning in the Social Sciences (IG))
FREC/NR/LAR 2554	Leadership for Global Sustainability (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 2 - Critical Thinking in the Humanities (E) (IG))
RLCL/SOC 2054	Ethnography: Studying Culture (Pathways Concept 3 - Reasoning in the Social Sciences (IG))
SOC 2034	Diversity and Community Engagement (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (IG))
SPAN 2764	Introduction to Latino American Studies (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 2 - Critical Thinking in the Humanities (E) (IG))
APS/STS 3124	Societal Health in North America (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (IG))
APS/AHRM/HD/GEOG/HUM/SOC/UAP 3464	Appalachian Communities
ENGL/SOC/RLCL 3144	Language and Ethnicity in the United States (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 1 - Discourse (IG))
GEOG 3224	Geography of Appalachia
HTM 3484	Socio-Cultural Impacts of Tourism (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 2 - Critical Thinking in the Humanities (IG))
LAR 3264	People Community and Place (Pathways Concept 3 - Reasoning in the Social Sciences)
RLCL/HUM 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences (IG))
STS 3334	Energy and Society (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 2 - Critical Thinking in the Humanities (IG))
ALS 4204	Concepts in Community Food Systems (Pathways Concept 3 - Reasoning in the Social Sciences (IG))
APS/SOC 4094	Appalachian Community Research
AINS 4004	Topics in American Indian Studies
Arts & Design	
LAR 1264	Seeing, Understanding and Representing Landscape and the Built Environment (Pathways Concept 6 - Critique and Practice in Design and the Arts (E))
APS/HUM 2404	Folk Cultures in Appalachia (Pathways Concept 6 - Critique and Practice in Design and the Arts Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (IG))
LAR 2254	Social and Cultural Landscapes
MUS/APS 2124	Music Traditions in Appalachia (Pathways Concept 6 - Critique and Practice in Design and the Arts (IG))
TA 2404	Introduction to Applied Collaborative Techniques (Pathways Concept 6 - Critique and Practice in Design and the Arts or Pathways Concept 1 - Discourse (IG))
LAR 3264	People Community and Place (Pathways Concept 3 - Reasoning in the Social Sciences)
Cultural Expressions & Values	
APS 2434	The Cultural Politics of Music in Appalachia (Pathways Concept 2 - Critical Thinking in the Humanities Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (IG))
FREC/NR/LAR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences (E) (IG))
SPAN 2764	Introduction to Latino American Studies (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences (E) (IG))
ENGL 3624	Appalachian Literature
HIST 3214	History of Appalachia
HTM 3484	Socio-Cultural Impacts of Tourism (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences (IG))
STS 3334	Energy and Society (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences (IG))
LAR 4034	Evolution of the American Landscape (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 1 - Discourse (IG))

Subtotal	12
Total Credits	**18**

[1] At least one must be at the 3000- or 4000-level. At least one must be a Pathways elective (courses listed in more than one area may be counted for either area but not for both areas).

Graduation Requirements

- With approval from the director of Appalachian Studies, up to six credits of applicable special offerings, such as Independent Study (APS 2974 Independent Study , APS 2974H Independent Study , APS 4974 Independent Study , or APS 4974H Independent Study) or APS 4994 Undergraduate Research , may be used to fulfill elective requirements.
- When appropriate, substitutions for electives may be made with approval from the director of Appalachian Studies.
- A minimum cumulative GPA for all classes taken for the minor is 2.0.
- Some courses listed on this checksheet may have prerequisites. Please consult the University Course Catalog, or check with your advisor.

For more information, contact the Director of Appalachian Studies, Dr. Emily Satterwhite, satterwhite@vt.edu

Arabic (ARBC) Minor

Code	Title	Credits
Required Minor Courses		
ARBC 2105	Intermediate Arabic	3
ARBC 2106	Intermediate Arabic	3
ARBC 2774	Arab Culture and Civilization	3
ARBC 3105	Advanced Arabic	3
ARBC 3106	Advanced Arabic	3
Select one of the following:		3
ARBC 3304	Modern Arabic Literature in Translation	
ARBC 3474	Topics in Arab Cinema	
ARBC 3274	War and Arab Culture	
Total Credits		**18**

Graduation Requirements

Notes:

- A student must complete all courses with a least a minimum 2.0 Minor GPA for all hours attempted. In addition, a minimum grade of "C" (2.0) must be earned in each course completed for the Arabic minor.
- Some courses in the minor requirements listed above have prerequisites, so students should consult the University Catalog or check with their advisor to ensure the proper fulfillment of course requirements.
- Courses used to fulfill minor requirements may not be taken as Pass/Fail.
- Before the student departs on a study abroad program, a form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the student's Arabic advisor, and the Director of the Office of Global Education.

Art History (AHST) Minor

Code	Title	Credits
Required Minor Courses		
ART 2385	Survey of the History of Western Art	3
ART 2386	Survey of the History of Western Art	3
Select two of the following:		6
ART 4184	Museum Studies: Theory and Practice	
ART 4284	Museum Ethics and Cultural Preservation	
ART 4384	Topics in Art History (May be taken twice to earn 6 credit hours.)	
ART 4684	Topics in Museums and Collections	
Subtotal		12
Elective Courses		
Select two of the following:		6
ART 3004	Topics in Art History	
ART 3034	Survey of Latin American Art and Architecture	
ART 3044	Art and Architecture of India	
ART 3054	Islamic Art and Architecture	
ART 3064	Arts of China and Japan	
ART 3074	Egyptian Art and Architecture	
ART 3084	Greek Art and Architecture	
ART 3094		
ART 3174	Introduction to Archaeology	
ART 3184	Roman Art and Architecture	
ART 3284	Medieval Art and Architecture	
ART 3384	Renaissance Art and Architecture	
ART 3484	Baroque and Rococo Art and Architecture	
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	
ART 3674	History of Photography	
ART 3684	African-American Art	
ART 3774	History of Modern Graphic Design	
ART 3784	European and American Art Since 1900	
ART 3884	American Art to 1914	
Subtotal		6
Total Credits		**18**

Graduation Requirements

Students must complete all courses comprising the minor with a GPA of 2.0 or better and maintain an overall GPA of 2.0.

Any courses taken for the Art History minor will count toward the in-minor GPA.

Asian Studies (ASIA) Minor

Code	Title	Credits
I. Foundational Courses		
3 credits, choose one of the following:		3
HIST 1354	Conflict and Security in Modern East Asia	
RLCL 1904	Religion and Culture In Asia	
HIST/RLCL 2394	Tofu to Tikka: Food in Asian History	

Subtotal		3
II. Elective Credit		
Select four courses, from at least two of the following groups:		12
a. History		
HIST 2355	History of China	
HIST 2356	History of Modern China	
HIST 2364	History of Japan	
HIST/RLCL 2374	Gods and Kings in Premodern India	
HIST/RLCL 2384	Gandhi in the Making of Modern India	
HIST 3254	The Vietnam War	
HIST 3664	Revolutionary China	
HIST 3674	Topics in Chinese History	
b. Culture and Society		
ART 3044	Art and Architecture of India	
ART 3054	Islamic Art and Architecture	
ART 3064	Arts of China and Japan	
CHN 2734	Chinese Culture and Civilization	
CHN 3304	Chinese Literature in Translation	
JPN 3304	Japanese Literature in Translation	
CHN 3474	Topics in Chinese Cinema	
JPN 2744	From Atom to Akira: Japan's Pop Culture	
RLCL/SOC 2514	Asian American Experience	
RLCL 2324	Islam	
RLCL 3214	Religion and Culture in India	
RLCL 3224	Religion and Culture in China and Japan	
c. Language [1]		
CHN 1105 & CHN 1106	Elementary Chinese and Elementary Chinese	
or CHN 1106	Elementary Chinese	
CHN 2105 & CHN 2106	Intermediate Chinese and Intermediate Chinese	
or CHN 2106	Intermediate Chinese	
CHN 3105 & CHN 3106	Advanced Chinese and Advanced Chinese	
or CHN 3106	Advanced Chinese	
CHN 3514	Modern China through the Media	
KOR 1105 & KOR 1106	Elementary Korean and Elementary Korean	
or KOR 1106	Elementary Korean	
JPN 1105 & JPN 1106	Elementary Japanese and Elementary Japanese	
or JPN 1106	Elementary Japanese	
JPN 2105 & JPN 2106	Intermediate Japanese and Intermediate Japanese	
or JPN 2106	Intermediate Japanese	
JPN 3105 & JPN 3106	Advanced Japanese and Advanced Japanese	
or JPN 3106	Advanced Japanese	
JPN 3125 & JPN 3126	Japanese for Oral Proficiency and Japanese for Oral Proficiency	
or JPN 3126	Japanese for Oral Proficiency	
JPN 4104	Japanese Advanced Grammar	
CHN 3604	Chinese Language and Society	
d. Social Sciences and Geography [1]		
ECON 4144	Economics of China	
PSCI 3574	Government and Politics of Japan	
PSCI 3584	Governments and Politics of Asia	
GEOG 2784	Geography of Tea	
GEOG 3254	Geography of East Asia	
Subtotal		12
III. Capstone Experience		
Select one of the following:		3
3xxx	Study abroad in Asia (options in AHRM, BUS, CHN, JPN, HIST, RLCL or other study abroad credits in Asia).	
HIST 4974	Independent Study	
RLCL 4974	Independent Study	
SOC 4974	Independent Study	
PSCI 4974	Independent Study	
IS 4974	Independent Study	
On subject related to Asian Studies, with prior approval of coordinator		
HIST/RLCL/ SOC/PSCI/IS 4994	Undergraduate Research	
On subject related to Asian Studies, with prior approval of coordinator		
3XXX or 4XXX	Topics class on subject related to Asian Studies, with prior approval of coordinator.	
Subtotal		3
Total Credits		**18**

Graduation Requirements

The Minor in Asian Studies (ASIA) requires the satisfactory completion of a minimum of 18 semester hours with a minimum 2.0 GPA in all courses. Courses must be taken for a grade (not P/F). Courses must be distributed as indicated, including at least 6 credits in 3000-4000 level courses. Substitutions are allowed for up to 6 credits of independent studies (4974), special studies courses (1984, 2984, 3984, 4984), undergraduate research, Honors Colloquia, or other classes if the topic is appropriate, with prior approval of the Coordinator. No more than 50% of the coursework for the Minor may double-count for a History Major or Minor, Chinese Studies Minor, Religion and Culture Minor, or Japanese Studies Minor.

Astronomy (ASTR) Minor

Code	Title	Credits
Required Minor Courses		
PHYS 1055	Introduction to Astronomy	3
PHYS 1056	Introduction to Astronomy	3
PHYS 1155	Astronomy Laboratory	1
PHYS 1156	Astronomy Laboratory	1
PHYS 3154	Observational Astrophysics	2
PHYS 3655	Introduction to Astrophysics	3
PHYS 3656	Introduction to Astrophysics	3
Subtotal		16
Elective Courses		

Select one of the following:		3
PHYS 3355	Intermediate Mechanics	
PHYS 3405	Intermediate Electricity and Magnetism	
PHYS 4574	Nanotechnology	
PHYS 4614	Optics	
PHYS 4654	Modern Cosmology	
PHYS 4664	Astroparticle Physics	
PHYS 4674	Introduction to General Relativity	
PHYS 4714	Introduction to Biophysics	
PHYS 4755	Introduction to Computational Physics	
PHYS 4774	Intro to Physics of Galaxies	
BIOL 2134	Cell Function and Differentiation	
BIOL 2704	Evolutionary Biology	
GEOS 4154	Earthquake Seismology	
GEOS 4714	Volcanoes and Volcanic Processes	
AOE 3154	Astromechanics	
ECE 4114	Antennas	
ECE 4124	Radio Wave Propagation	
ECE 4144	Optical Systems	
ESM 3024	Introduction to Fluid Mechanics	
Subtotal		3
Total Credits		**19**

Graduation Requirements

Acceptable Substitutions:

- PHYS 3355 Intermediate Mechanics: AOE 3154 Astromechanics, **or** ESM 3124 Dynamics II- Analytical and 3-D Motion.
- PHYS 3405 Intermediate Electricity and Magnetism: ECE 3105 Electromagnetic Fields.

Minimum Hours and GPA Required for Graduation

A minimum overall and in-minor GPA of 2.0 is required for graduation. All minor courses attempted are used in the calculation of the in-minor GPA.

Prerequisites and Corequisites

Courses in this minor have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Behavioral Decision Science (BDS) Minor

Code	Title	Credits
Required Minor Courses		
BDS 2005	Fundamentals of Behavioral Decision Science	3
BDS 2006	Fundamentals of Behavioral Decision Science	3
ECON/BDS 3134	Choice and Behavior	3
Subtotal		9
Elective Courses		
Select two of the following:		*6*
ECON 3034	Economics of Poverty and Discrimination	
ECON 3154	Managerial Economics	
ECON 4014	Environmental Economics	
ECON 4214	Economics of Health Care	
NEUR 2464	Neuroscience and Society	
NEUR 3084	Cognitive Neuroscience	
PSYC 2014	Psychology of Social Interventions	
PSYC 2084	Social Psychology	
PSYC 3054	Health Psychology	
PSYC 4184	The Science of Giving	
Subtotal		6
Capstone		
Select one of the following:		*3*
BDS 4864	Developing Behavioral Science Policies and Interventions	
BDS 4194	Predicting Social Behavior	
BDS 4974		
BDS 4974H		
BDS 4994		
BDS 4994H		
Subtotal		3
Total Credits		**18**

Graduation Requirements

1. A minimum of 18 credit hours is needed to complete the minor.

2. Prerequisites and corequisites for all courses must be satisfied. Please consult the University Catalog for the latest statement of these requirements.

3. BDS 2005, BDS 2006, BDS 3134 and one of the required electives must be completed prior to beginning the Capstone requirement, which is assumed to be the final course for fulfillment of the minor.

4. All course to fulfill the BDS minor requirements must be taken A/F and be completed with a minimum GPA of 2.0. Students must also maintain an overall GPA of 2.0.

Biodiversity Conservation (BIOD) Minor

Code	Title	Credits
Required Foundational Courses		
FREC 1004/ GEOG 1084	Digital Planet (Pathways Concept 5 - Quantitative and Computational Thinking)	3
FIW 2114	Principles of Fish and Wildlife Conservation (Pathways Concept 4 - Reasoning in the Natural Sciences)	3
Subtotal		6
Mid-Level Courses		
Select 3 courses from the two restricted Elective groups:		9-10
One course from the Human Dimensions Area		
One course from the Natural Resources Area		
One course from either the Human Dimensions or Natural Resources area		
Subtotal		9-10
Required Capstone Course		
FIW 4114	Biodiversity Conservation (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 4 - Reasoning in the Natural Sciences) [1]	3

Subtotal		3
Total Credits		**18-19**

Code	Title	Credits
Restricted Electives		
Human Dimensions		
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States) [1]	3
FIW 2334	Urbanization and Biodiversity Conservation	3
FIW 2514	Fish and Wildlife Conservation Policy (Pathways Concept 3 - Reasoning in the Social Sciences)	3
FIW 4454	Human-Wildlife Conflicts	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 3144	American Environmental History (Pathways Concept 2 - Critical Thinking in the Humanities Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities)	3
Natural Resource		
FIW 2234	Fish, Fishing, and Conservation (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 4 - Reasoning in the Natural Sciences) [1]	3
FIW 2324	Wildlife Field Biology	3
FIW 4244	Applied Epidemiology of Fish and Wildlife Diseases	3
FIW/FREC 4324	Genetics of Natural and Mangaged Populations	3
FIW 4424	Ichthyology	4
FIW 4454	Human-Wildlife Conflicts	3
FIW 4534	Ecology and Management of Wetland Systems	3
FIW 4614	Fish Ecology	3
FREC 3364	Environmental Silviculture	3

[1] Where more than one outcome is listed, only one outcome may be counted unless it is outcome 7, which may be double counted with another outcome.

Graduation Requirements

Notes for Biodiversity Conservation Pathways Minor:

1. Students in the Fish and Wildlife Conservation Degree (Wildlife Conservation, Freshwater Fish Conservation, Marine Fish Conservation , Fish Conservation/Human Dimension Option, Wildlife Conservation/Human Dimensions Option) are not eligible to declare the Biodiversity Conservation Pathways Minor.
2. At least two courses taken must be at the 3000-4000 level.
3. Any course substitution requests of the courses above must be proposed in writing to the College of Natural Resources and Environment Advising Center in 138 Cheatham Hall.
4. Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog, or check with your advisor.
5. A minimum cumulative GPA for all classes taken for the minor is 2.0

Steps for Completing the Biodiversity Conservation Minor

1. Make an advising appointment with the Biodiversity Conservation Minor Coordinator for orientation to the minor.
2. Declare the Biodiversity Conservation minor at the CNRE Advising Center in 138 Cheatham Hall.
3. Include minor information when updating the application for degree in Hokie Spa.
4. Students cannot graduate until they have either (1) satisfied the requirements for the minor or (2) withdrawn from the minor by notifying CNRE Advising Center office in 138 Cheatham and revising their DARS.

Biological Physics (BIPH) Minor

Code	Title	Credits
Required Minor Courses		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
PHYS 4714	Introduction to Biophysics	3
BIOL 2124	Cell and Molecular Biology for Engineers [1]	2
Subtotal		13
Elective Courses		
Select 9 credits of the following:		9
PHYS 3704	Thermal Physics	
PHYS 4564	Polymer Physics	
PHYS 4574	Nanotechnology	
PHYS 4614	Optics	
PHYS 4755	Introduction to Computational Physics	
BIOL 3774	Molecular Biology	
BIOL 4884	Cell Biology	
SYSB 2024	Fundamentals of Systems Biology	
Subtotal		9
Total Credits		**22**

Graduation Requirements

Acceptable Substitutions:

BIOL 2134 Cell Function and Differentiation is an acceptable substitution for BIOL 2124 Cell and Molecular Biology for Engineers.

Minimum Hours and GPA Required for Graduation:

A minimum overall and in-minor GPA of 2.0 is required for graduation. All physics courses attempted are used in the calculation of the in-minor GPA.

Prerequisites and Corequisites:

Courses in this minor have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Biological Sciences (BIOL) Minor

Code	Title	Credits
Required Minor Courses		
BIOL 1105	Principles of Biology [1]	3
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1106	Principles of Biology [1]	3
BIOL 1116	Principles of Biology Laboratory [1]	1
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2704 or BIOL 2704H	Evolutionary Biology [#]	3
BIOL 2804 or BIOL 2804H	Ecology [#]	3
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
Subtotal		26
Elective Courses		
Select two of the following:		6-8
BIOL 3134	Human Genetics [#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3404	Introductory Animal Physiology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3514	Introduction to Histology [#]	
BIOL 3774	Molecular Biology [#]	
BIOL 3954	Study Abroad (var credit) [2,#]	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4104	Developmental Biology [#]	
BIOL 4114	Global Change Ecology [#]	
BIOL 4134	Evolutionary Genetics [#]	
BIOL 4334	Chemical Ecology [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL/ALS 4554	Neurochemical Regulation [#]	
BIOL 4594	Ecology, Evolution, and Behavior Senior Seminar [#]	
BIOL 4664	Virology [#]	
BIOL 4734	Inflammation Biology [#]	
BIOL 4474	Ethology [#]	
BIOL 4844	Proteomics and Biological Mass Spectrometry [#]	
BIOL 4854	Cytogenetics [#]	
BIOL 4864	Clinical Biology [#]	
BIOL 4874	Cancer Biology [#]	
BIOL 4884	Cell Biology [#]	
Subtotal		6-8
Total Credits		**32-34**

Notes

[1] Students must earn a "C" or better in BIOL 1105, 1106, 1115, 1116, CHEM 1035, and CHEM 1036, or the equivalent. Only two attempts are allowed for each course.

[2] If BIOL 3954 is taken to fulfill minor requirements, the course must be taken for at least 3 credits.

[#] Some courses listed on this checksheet may have prerequisites; please consult the University Course Catalog or check with your advisor.

Cross-listed Courses on this Checksheet

ALS/BIOL 4554: Neurochemical Regulation

Acceptable Substitutions

CHEM 1035:	CHEM 1055 General Chemistry for Majors
CHEM 1036:	CHEM 1056 General Chemistry for Majors

Graduation Requirements

Students must have an in-minor and overall GPA of 2.0 to graduate. All courses taken to fulfill minor requirements will count toward the in-minor GPA.

Students must earn a "C" or better in BIOL 1105, 1106, 1115, 1116, CHEM 1035, and CHEM 1036, or the equivalent. Only two attempts are allowed for each course.

Biomedical Engineering (BME) Minor

Code	Title	Credits
Required Minor Courses		
BMES 2104	Introduction to Biomedical Engineering	3
BMES 4064	Introduction to Medical Physiology	3
Subtotal		6
Approved BME Research		
Students may pursue one or a combination of the following options in order to fulfill this requirement:		6
Senior Design Courses		
BSE 4125	Comprehensive Design Project	
BSE 4126	Comprehensive Design Project	
ECE 4805	Senior Design Project	
ECE 4806	Senior Design Project	
ENGE 4735	Interdisciplinary Design Capstone	
ENGE 4736	Interdisciplinary Design Capstone	
ISE 4005	Project Management and Systems Design	
ISE 4006	Project Management and Systems Design	
ME 4015	Engineering Design and Project	
ME 4016	Engineering Design and Project	
MSE 4075	Senior Design Laboratory	
MSE 4076	Senior Design Laboratory	
MINE 4635	Mining Engineering Capstone	
MINE 4636	Mining Engineering Capstone	
Departmental Undergraduate Research Course		
AOE 4994	Undergraduate Research	
BMES 4994	Undergraduate Research	
BMES 4994H	Undergraduate Research	
BMVS 4994	Undergraduate Research	
BSE 4994	Undergraduate Research	
CEE 4994	Undergraduate Research	
CHE 4994	Undergraduate Research	

CS 4994	Undergraduate Research	
ECE 4994	Undergraduate Research	
ESM 4994	Undergraduate Research	
ISE 4994	Undergraduate Research	
ME 4994	Undergraduate Research	
MSE 4994	Undergraduate Research	
MINE 4994	Undergraduate Research	
Subtotal		6
Approved Electives		
Select 2 courses from the BME Minor Approved Electives list below:		6
Subtotal		6
Total Credits		**18**

Below listed elective courses have pre- and/or co-requisites.

BME Minor Approved Electives

Code	Title	Credits
Undergraduate Level Courses [1]		
BMES 3004	Helmet Design: Biomechanics to Health & Social Disparities in Sports	
BMES 3124	Introduction to Biomechanics	
BMES 3134	Introduction to Biomedical Imaging	
BMES 3144	Biomedical Devices	
BMES 3154	Biosignal Processing and Classification	
BMES 3164	Fundamentals of Regenerative Medicine and Tissue Engineering	
BMES 3224	Automobile Safety	
BMES/NEUR 3844	Computational Neuroscience and Neural Engineering	
BMES 4034	Wearable Bioinstrumentation	
BMES 4134	Global, Societal, and Ethical Considerations in Biomedical Engineering	
BMES 4154	Commercialization of BME Res	
BMES/MSE 4574	Biomaterials	
BMES 4614	Probability-Based Modeling, Analysis, and Assessment	
BSE/CHE 4544	Protein Separation Engineering	
BSE 4564	Metabolic Engineering	
CHE 4104	Process Materials	
CHE 4304/ ME 4344	Biological Transport Phenomena	
CS 4784	Human-Computer Interaction Capstone	
CS 4884	Computational Biology and Bioinformatics Capstone	
ECE 4580	Digital Image Processing	
ECE 4624	Digital Signal Processing And Filter Design	
ESM 4105	Engineering Analysis of Physiologic Systems	
ESM 4106	Engineering Analysis of Physiologic Systems	
ESM 4204	Musculoskeletal Biomechanics	
ESM 4224	Biodynamics and Control	
ESM 4234	Mechanics of Biological Systems	
ESM 4245	Mechanics of Animal Locomotion	
ESM 4246	Mechanics of Animal Locomotion	
ESM 4304	Hemodynamics	
ISE 4624	Physical Work Assessment	
ME 4824	Introduction to Human-Robot Interaction	
ME 4864	Micro/Nano-Robotics	
MSE 4584	Biomimetic Materials	
MSE 4614	Nanomaterials	
Graduate Level Courses [1,2]		
BMES 5024/ BMVS 5224	Biomedical Engineering and Human Disease	
BMES/BSE/ CHE 5044	Engineering Mathematics	
BMES 5054	Quantitative Cell Physiology	
BMES 5064	Quantitative Organ Systems Physiology	
BMES 5074	Biomedical Research Design	
BMES 5154G	Advanced Commercialization of Biomedical Engineering Research	
BMES 5124/ ESM 5224	Advanced Musculoskeletal Biomechanics	
BMES 5164	Advanced Impact Biomechanics	
BMES/ME 5174	Biomechanics of Crash Injury Prevention	
BMES 5184	Injury Physiology	
BMES 5204	Laboratory Techniques in Injury Prevention	
BMES 5214/ ISE 5614	Human Physical Capabilities	
BMES 5234	Advanced Vehicle Safety Systems	
BMES 5304G	Advanced Biological Transport Phenomena	
BMES 5304	Biological Transport Phenomena	
BMES/ESM 5305	Biomechanics of the Cardiovascular System	
BMES/ESM 5306		
BMES 5314	Introduction to Regenerative Medicine	
BMES 5434/ CHE 5214	Polymeric Biomaterials	
BMES 5514/ ME 5714	Digital Signal Processing for Mechanical Measurements	
BMES 5525/ ECE 5605	Stochastic Signals and Systems	
BMES 5534	Advanced Computational Methods and Modeling for Biomedical Applications	
BMES 5554	Imaging and Computing in Medicine	
BMES 5574	Advanced Biomaterials	
BMES 5604	Cancer Detection and Therapeutics	
BMES 5614	Multiscale Cancer Engineering	
BMES 5714	Biomedical Microdevices	
BMES 5724	Biomedical Nanoengineering	
BMES 5764	Modeling MEMS and NEMS	
CHE 5214/ BMES 5434	Polymeric Biomaterials	
ECE 5605/ BMES 5525	Stochastic Signals and Systems	
ECE 5606	Stochastic Signals and Systems	
ESM 5405	Clinical Internship in Biomedical Engineering	

ESM 5406	Clinical Internship in Biomedical Engineering
ISE 5154	Applied Human Factors Engineering
ISE 5614/ BMES 5214	Human Physical Capabilities
ISE 5644	Human Audition and Auditory Display Design
ME/BMES 5764	Modeling MEMS and NEMS
ME 5864G	Advanced Micro/Nano-Robotics

[1] Note, the courses offered as electives may have hidden prerequisites. It is the responsibility of the student to assure that all prerequisites are met prior to registration for these courses.

[2] 5000-level courses are typically restricted based on amount of total credit hours completed, GPA, and available seats after graduate student registration. Please contact the department's undergraduate academic advisor regarding registering for 5000-level courses.

Graduation Requirements

To obtain a minor in Biomedical Engineering (BME) students must first be accepted into the BME minor program. Once accepted, a student must take 6 hours of required coursework, 6 hours of approved elective courses, and 6 hours of approved BME research for a total of 18 credits. No pass/fail courses will be accepted.

Blue Planet (BLPL) Minor

Code	Title	Credits
Required Foundational Course		
GEOG/WATR 2004	Water, Environment, and Society (Pathways Concept 3 - Reasoning in the Social Sciences)	3
Subtotal		3
Specialization Options		
Choose one specialization (Water and Society or Science of Water) (9 credits)		9
Water and Society Specialization		
AAEC 1005	Economics of the Food and Fiber System (Pathways Concept 3 - Reasoning in the Social Sciences)	
OR		
ECON 2005	Principles of Economics (Pathways Concept 3 - Reasoning in the Social Sciences)	
FREC/WATR/ AAEC 4464	Water Resources Policy and Economics (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
FREC/LAR/NR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
OR		
HIST 3144	American Environmental History (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
Science of Water Specialization		
FREC/WATR 3104	Principles of Watershed Hydrology	
MATH 1025	Elementary Calculus (Pathways Concept 5 - Quantitative and Computational Thinking)	
OR		
MATH 1225	Calculus of a Single Variable (Pathways Concept 5 - Quantitative and Computational Thinking)	
MATH 1026	Elementary Calculus (Pathways Concept 5 - Quantitative and Computational Thinking)	
OR		
MATH 1226	Calculus of a Single Variable (Pathways Concept 5 - Quantitative and Computational Thinking)	
Subtotal		9
Required Capstone Course		
ALS/WATR 4614	Watershed Assessment, Management, and Policy [1]	2
REQUIRED NATURAL SCIENCES RESTRICTED ELECTIVE		**3**
Subtotal		5
Choose ONE class from the following list:		
ENSC 1015	Foundations of Environmental Science	
ENSC 1016	Foundations of Environmental Science	
FREC 2004	Forest Ecosystems (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC 2114	Ecology of Appalachian Forests (Pathways Concept 4 - Reasoning in the Natural Sciences)	
GEOS 1024	Earth Resources, Society, and Environment (Pathways Concept 4 - Reasoning in the Natural Sciences)	
GEOS 1064	Climate History: Past, Present, and Future (Pathways Concept 4 - Reasoning in the Natural Sciences)	
LAR 1254	Environment and Natural Systems (Pathways Concept 4 - Reasoning in the Natural Sciences or Pathways Concept 5 - Quantitative and Computational Thinking)	
REQUIRED RESTRICTED ELECTIVE		**3**
Choose ONE class from the following list:		
AAEC 3314	Environmental Law	
BSE 4394	Water Supply and Sanitation in Developing Countries	
ENGL 3534	Literature and the Environment (Pathways Concept 1 - Discourse or Pathways Concept 2 - Critical Thinking in the Humanities)	
FIW 2114	Principles of Fish and Wildlife Conservation (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC 3044	Environmental Data Science (Pathways Concept 5 - Quantitative and Computational Thinking)	
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework (Pathways Concept 1 - Discourse or Pathways Concept 3 - Reasoning in the Social Sciences)	
FREC 4354	Forest Soil and Watershed Management (Pathways Concept 5 - Quantitative and Computational Thinking)	
GEOG 2114	Introduction to Coastal Regions	
GEOG/GEOS 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences)	

GEOG/GEOS 4134	Interdisciplinary Issues and Ethics in Water Resources (Pathways Concept 3 - Reasoning in the Social Sciences)	
GEOG/NR 1115	Seeking Sustainability (Pathways Concept 3 - Reasoning in the Social Sciences)	
GEOS 3034	Oceanography	
UAP 4374	Land Use and Environment: Planning and Policy	
Total Credits		**20**

1 Courses may have prerequisites, corequisites, or other restrictions. Please consult the University Course Catalog, or check with your advisor.

Graduation Requirements

20 Credit Hours Required for Minor

Notes:

1. All courses for the Blue Planet minor must be taken A/F and be completed with a minimum in-minor GPA of 2.0. Any course taken to fulfill the Blue Planet minor will count towards the minor GPA.
2. No more than 50% of the graded course credits required for the Blue Planet minor may be double-counted by a student in the Water: Resources, Policy, and Management major.
3. A minimum of 6 hours of 3000/4000 level courses are required for the minor.

Key to Pathways Learning Core Outcomes:

1f = Foundational Discourse

1a = Advanced/Applied Discourse

2 = Critical Thinking in the Humanities

3 = Reasoning in the Social Sciences

4 = Reasoning in the Natural Sciences

5f = Foundational Quantitative and Computational Thinking

5a = Advances/Applied Quantitative and Computational Thinking

6 = Critique and Practice in Design and the Arts

7 = Critical Analysis of Equity and Identity in the United States

Business (BUSR) Minor

Code	Title	Credits
ACIS 1504	Introduction to Business Analytics and Business Intelligence (Pathways Concept 5 - Quantitative and Computational Thinking 5F)	3
ACIS 2115 & ACIS 2116	Principles of Accounting and Principles of Accounting	6
BIT 2405 & BIT 2406	Introduction to Business Statistics, Analytics, and Modeling and Introduction to Business Statistics, Analytics, and Modeling (Pathways Concept 5 - Quantitative and Computational Thinking 5F 5A) [1]	6
BIT 3414	Operations and Supply Chain Management	3
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics (Pathways Concept 3 - Reasoning in the Social Sciences)	6
FIN 3104	Introduction to Finance	3
HTM/MGT 2314	Introduction to International Business	3
MATH 1524	Business Calculus (Pathways Concept 5 - Quantitative and Computational Thinking 5F) [2]	4
MGT 1104	Foundations of Business	3
MGT 3404	Principles of Management	3
MKTG 3104	Marketing Management	3
Select one of the following:		3
FIN 3054	Legal and Ethical Environment of Business (Pathways Concept 3 - Reasoning in the Social Sciences)	
FIN 3074	Legal, Ethical, and Financing Issues for Entrepreneurs	
Total Credits		**46**

[1] The following courses may be substituted for BIT 2405:
- CMDA 2005 Integrated Quantitative Sciences + CMDA 2006 Integrated Quantitative Sciences
- STAT 3005 Statistical Methods + STAT 3006 Statistical Methods
- STAT 3604 Statistics for Social Science
- STAT 3615 Biological Statistics + STAT 3616 Biological Statistics
- STAT 4604 Statistical Methods for Engineers

[2] The following courses may be substituted for MATH 1524:
- MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable

Graduation Requirements

Business minors must complete a minimum of **46 credit hours** with at least a 2.00 GPA. Students must earn a grade of C- or better in each course. If these criteria are met, the minor will be noted on the transcript.

Application Eligibility

In order to apply for a minor in Business, students must meet the following criteria:

- be enrolled in a degree-granting major outside the Pamplin College of Business (Real Estate for Commercial Properties and Real Estate for Residential Properties majors are eligible to pursue the Business minor)
- have at least a 2.00 overall GPA at Virginia Tech
- have completed MATH 1524 (or equivalents)

Students can apply for the business minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Additional Information

Industrial Systems & Engineering (ISE) majors ONLY may substitute courses as listed below:

- ISE 2034 for ACIS 1504
- ISE 3004 for ACIS 2116
- STAT 4706 for BIT 2405
- ISE 2404 + ISE 3414 for BIT 2406
- ISE 4004 for MGT 3404
- ISE 4204 for BIT 3414

Chemistry (CHEM) Minor

Code	Title	Credits
Required Minor Courses		
CHEM 1035	General Chemistry [1, 2]	3
CHEM 1036	General Chemistry [1, 2]	3
CHEM 1045	General Chemistry Laboratory [1, 2]	1
CHEM 1046	General Chemistry Laboratory [1, 2]	1
CHEM 2535	Organic Chemistry [2]	3
CHEM 2536	Organic Chemistry [2]	3
CHEM 2545	Organic Chemistry Laboratory [2]	1
CHEM 2546	Organic Chemistry Laboratory [2]	1
CHEM 4615	Physical Chemistry for the Life Sciences [1, 2]	3
or CHEM 4616	Physical Chemistry for the Life Sciences	
Subtotal		19
Elective Courses		
Select one of the following:		3
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BCHM 4115	General Biochemistry [2]	
CHEM/SBIO 4424	Polysaccharide Chemistry [2]	
CHEM 4514	Green Chemistry [2]	
CHEM 4534	Organic Chemistry of Polymers [2]	
CHEM 4554	Drug Chemistry [2]	
CHEM 4616	Physical Chemistry for the Life Sciences [2]	
CHEM 4634	Polymer and Surface Chemistry [2]	
CHEM/ENSC 4734	Environmental Soil Chemistry [2]	
CHEM 4994	Undergraduate Research (3 credits must be completed. Requires permission of faculty research advisor and undergraduate research eligibility requirements)	
SBIO 3444	Sustainable Biomaterials and Bioenergy [2]	
FST 4504	Food Chemistry [2]	
GEOS 4634	Environmental Geochemistry [2]	
CHEM 4584	Bioorganic Chemistry [2]	
Subtotal		3
Total Credits		**22**

[1] Acceptable course substitutions are as follows:
CHEM 1055 may be substituted for CHEM 1035
CHEM 1056 may be substituted for CHEM 1036
CHEM 1065 may be substituted for CHEM 1045
CHEM 1066 may be substituted for CHEM 1046
CHEM 3615 or CHE 2164may be substituted for CHEM 4615.

[2] Course has prerequisites. Please check the course catalog for details.

Graduation Requirements

A minimum of 22 credit hours must be completed. No more than 16 credits earned toward the CHEM minor may be double-counted among a student's major(s) or minor(s). The overall GPA for the courses within the CHEM minor must be 2.0 or higher. All courses used to fulfill the minor will count toward the Minor GPA.

Chinese Studies (CHNS) Minor

Code	Title	Credits
Required Minor Courses		
CHN 2105	Intermediate Chinese	3
CHN 2106	Intermediate Chinese	3
CHN 3105	Advanced Chinese	3
CHN 3106	Advanced Chinese	3
Select two of the following:		6
CHN 3954	Study Abroad	
CHN 2734	Chinese Culture and Civilization	
CHN 3124	Chinese for Oral Proficiency	
CHN 3474	Topics in Chinese Cinema	
CHN 3514	Modern China through the Media	
CHN 4614	Teaching Chinese	
RLCL 1904	Religion and Culture In Asia	
RLCL 3224	Religion and Culture in China and Japan	
HIST 2355	History of China	
HIST 2356	History of Modern China	
HIST 3664	Revolutionary China	
HIST 3674	Topics in Chinese History	
ART 3064	Arts of China and Japan	
PSCI 3584	Governments and Politics of Asia	
Subtotal		18
Total Credits		**18**

Graduation Requirements

Notes:

- A minimum grade of "C" must be earned in each course completed for the Chinese Studies minor and an average GPA of 2.0 in all courses taken for the Chinese Studies minor is required for completion.
- Courses used to fulfill minor requirements may not be taken Pass/Fail.
- A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the Chair of the Department, and the Director of the Office of Global Education before the student departs on a study abroad program.
- Some courses in the minor requirements listed above have prerequisites, so be sure to consult the University Catalog or check with your advisor.

Cinema (CINE) Minor

Code	Title	Credits
Required Minor Courses		
CINE 2054	Introduction to Cinema	3
Subtotal		3

Elective Courses		
Select five of the following:		15
CINE 2064	Introduction to Cinema Production	
CINE 3214	Fiction Cinema Production	
CINE 3224	Documentary Cinema Production	
CINE 3184	Cinema Production Topics [1]	
CINE 3514	American Cinema Genres	
CINE 3524	The Cinema Director	
CINE 3534	Avant-Garde Cinema	
CINE/ENGL 3544	Literature and Cinema	
AFST/CINE 3444	African American Images in Film	
CINE 4084	Cinema History	
CINE 4534	Underground Cinema and Culture	
CINE 4144	Topics in Cinema Studies [1]	
Subtotal		15
Total Credits		**18**

[1] May be repeated 2 times with different content for a maximum of 9 credits.

Graduation Requirements

A minimum of 6 credit hours must be completed at the 3000 or 4000 academic level.

A minimum GPA of 2.0 is all courses taken to fulfill the minor is required.

Film or cinema focused courses from other departments across the university may be used to fulfill requirements for the minor upon approval by the minor coordinator.

Up to six hours of special offerings, such as Independent Study (4974) or Undergraduate Research (4994) in any department may be used to fulfill requirements for the minor where appropriate. Permission to include such courses must be granted by the minor coordinator.

Civic Agriculture and Food Systems (CAFS) Minor

The minor in Civic Agriculture and Food Systems embodies a commitment to developing and strengthening an economically, environmentally, and socially sustainable system of agriculture and food systems that relies on local resources and serves local markets and citizens. The minor serves the needs of all students and is designed to promote academic enhancement, personal growth, and civic engagement while strengthening student's capacity to learn about civic agriculture and food systems through reflection and experiential practice to solve real-world problem. The minor in Civic Agriculture and Food Systems requires the completion of 18 credits; 12 credits required courses and 6 credits free electives from the list provided. All courses must be taken and passed on an A–F basis unless only offered on P/F basis.

Code	Title	Credits
Required Minor Courses		
ALS 2204	Sustainable Food Systems (Pathways Concept 1 - Discourse (advanced); Pathway 11 - Intercultural and Global Awareness)	3
ALS 3404	Ecological Agriculture: Theory and Practice (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways 10 - Ethical Reasoning)	3
ALS 4204	Concepts in Community Food Systems (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways 11- Intercultural and Global Awareness)	3
ALS 4214	Capstone: Civic Agriculture and Food Systems (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Pathways 10 - Ethical Reasoning)	3
Subtotal		12
Free Electives		
Select two of the following:		6
AAEC 1005/1006	Economics of the Food and Fiber System	
AAEC 3204	International Agricultural Development and Trade	
AAEC 3324	Environment and Sustainable Development Economics	
AAEC 4204	Food and Agricultural Policy	
AAEC 4344	Sustainable Development Economics	
AAEC 4814	Food and Health Economics	
ALCE 3004	Educational Programs in Agricultural and Life Sciences	
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations	
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ALCE 3634	Communicating Ag and Life Sciences in Speaking	
ALS 1004	Agriculture, the Arts and Society	
ALS 2504	Animals in Society	
ALS 3954	Study Abroad (max 1-3 credit hours)	
ALS 4964	Field Study/Practicum (max 1-3 credit hours)	
ALS 4994	Undergraduate Research (max 1-3 credit hours)	
APSC 1454	Introduction to Animal and Poultry Science	
DASC/APSC 3134	Animal Agriculture and the Environment	
ENSC 1015/1016	Foundations of Environmental Science	
CSES 4544	Forage Crop Ecology	
CSES/ENSC 4444	Managed Ecosystems, Ecosystem Services, and Sustainability	
HIST 3144	American Environmental History	
HTM 2454	Global Travel & Tourism Management	
HORT 2134	Plants and Greenspaces in Urban Communities	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2234	Environmental Factors in Horticulture	
HORT 2834	Sustainable Agriculture Practicum	
HORT 4835 & HORT 4845	Organic Vegetable Production and Organic Vegetable Production Laboratory	
HNFE 4624	Community Nutrition	
Subtotal		6
Total Credits		**18**

Minimum GPA of 2.0 in all courses taken to fulfill the minor is required. Faculty advisor in the Office of Academic Programs with civic agriculture food systems experience will serve as a counterpart to the student's

major advisor. Students choosing Civic Agriculture & Food Systems will register with the Office of Academic Programs in the College of Agriculture & Life Sciences, 1060 Litton-Reaves Hall. This will enable the college to provide any pertinent assistance, materials & information to the student. The student will consult with the professor of any course that requires prerequisites. The checksheet contains no hidden prerequisites.

Classical Languages (CLL) Minor

Code	Title	Credits
Required Minor Courses		
Select eighteen semester hours of coursework in Latin and/or Classical and New Testament Greek from the following: [1]		18
LAT 1105	Elementary Latin	
LAT 1106	Elementary Latin	
LAT 2104	Cicero and Livy	
LAT 2114	Latin Epic: Vergil and Ovid	
LAT 2124	Latin Lyric: Catullus and Horace	
LAT 2134	Late Medieval Latin	
LAT 2984	Special Study	
LAT 3004	Readings in Latin Literature	
LAT 4004	Directed Studies in Latin Prose Composition	
LAT 4974	Independent Study (variable credit) [2]	
LAT 4984	Special Study	
LAT 4994	Undergraduate Research (variable credit) [2]	
LAT 5974	Independent Study (variable credit) [2]	
LAT 5984	Special Study (Graduate)	
LAT 5994	Research and Thesis (variable credit) [2]	
GR 1105	Classical and New Testament Greek	
GR 1106	Classical and New Testament Greek	
GR 2104	Greek New Testament	
GR 2114	Readings in Classical Greek Literature	
GR 2974	Independent Study (variable credit) [2]	
GR 2984	Special Study [2]	
GR 4974	Independent Study (variable credit) [2]	
GR 4984	Special Study [2]	
GR 4994	Undergraduate Research (variable credit) [2]	
Total Credits		**18**

[1] Including at least 6 credit hours at the 3000 or 4000 level. With the exception of LAT 1105 Elementary Latin, LAT 1106 Elementary Latin, GR 1105 Classical and New Testament Greek, GR 1106 Classical and New Testament Greek, and LAT 4004 Directed Studies in Latin Prose Composition, all courses are variable-content courses and may be repeated for credit up to three times with different content. For substitutions, see your advisor for Classical Languages.

[2] Course can be included in the Minor *only* with permission of your advisor.

Graduation Requirements

- All courses taken from among those listed above will be included in the calculation of the minor GPA.
- A student must complete all courses with a minimum 2.0 GPA for all hours attempted. In addition a minimum grade of C is required of all Foreign Language Minors in each of the required courses for the minor.
- Required courses may be transferred only with the approval of your advisor for the Latin Minor.
- Authorization to take coursework elsewhere should be obtained beforehand from the Dean's Office and the Chair of the Department of Modern and Classical Languages and Literatures.

N.B.

1. CLA 2444 Ancient Greek and Roman Mythology (= ENGL 2444 Ancient Greek and Roman Mythology and RLCL 2444 Greek and Roman Myth) and CLA 2454 Topics in Ancient Greek and Latin Literature do not count toward a Latin Minor.
2. No course required for the Classical Language Minor may be taken Pass/Fail.
3. Some courses listed on this checksheet may have pre-/corequisites; please consult the University Course Catalogue.

Classical Studies (CLA) Minor

The Minor in Classical Studies in the Department of Modern and Classical Languages and Literatures requires the completion of 18 credit hours from the following list. At least 6 credit hours must be at the 3000 or 4000 level. 6 credit hours maximum may be counted at the 1000 level.

Code	Title	Credits
Required Minor Courses		
Select 6 courses of the following:		18
ART 3074	Egyptian Art and Architecture	
ART 3084	Greek Art and Architecture	
ART 3174	Introduction to Archaeology	
ART 3184	Roman Art and Architecture	
CLA/RLCL 1134	The Ancient Mediterranean World	
CLA 2434	Fairytale, Folklore, and Magic: Popular Literature in Ancient Greece and Rome	
CLA/ENGL/ RLCL 2444	Ancient Greek and Roman Mythology	
CLA 2454	Topics in Ancient Greek and Latin Literature	
CLA 2464	Mythology, Philosophy and Video Games	
CLA 3954	Study Abroad	
GR 1105	Classical and New Testament Greek	
GR 1106	Classical and New Testament Greek	
HIST 1024	Ancient History	
HIST/CLA 2224	Ancient Greek and Roman Women	
HIST/CLA 2234	Classics in the Modern World	
HIST 3274	The Greek City	
HIST 3284	The Roman Revolution	
HIST 3294	Roman Britain	
HIST 3304	The World of Alexander the Great	
HIST 3314	The Later Roman Empire	
LAT 1105	Elementary Latin	
LAT 1106	Elementary Latin	
PHIL 2115	Ancient Through Medieval Philosophy	

RLCL 2424	New Testament	
RLCL 3414	Jesus in Earliest Christianity	
RLCL 3424	Orthodoxy and Heresy in Early Christianity	
Subtotal		18
Total Credits		**18**

When o#ered, the following courses may also be included in the Classical Studies minor by substitution, when the topics pertain to Classical Studies. Consult the Classical Studies advisor.

Code	Title	Credits
ART 3004	Topics in Art History	3
RLCL 4324	Topics in Religion and Culture	3
PHIL 4014	Special Topics in Philosophy	3

Students must maintain a 2.0 GPA in the Classical Studies minor. The in-minor GPA is calculated as the GPA in all courses the student has taken in the Classical Studies minor. A minimum grade of C (2.0) must be earned by Classical Studies minors in all courses taken to satisfy the Classical Studies minor.

Independent Study (CLA 2974 Independent Study or CLA 4974 Independent Study), Special Study (CLA 2984 Special Study and CLA 4984 Special Study), or Undergraduate Research (CLA 4994 Undergraduate Research) in any department may also be substituted *if the topic is fitting*; consult the Classical Studies advisor. Substitutions must be approved by the Classical Studies advisor. No course taken Pass/Fail can be included in a Classical Studies Minor.

All classes are three credits.

Graduation Requirements

The Minor in Classical Studies in the Department of Modern and Classical Languages and Literatures requires the **completion of 18 credit hours** from the following list. At least 6 credit hours must be at the 3000 or 4000 level. 6 credit hours maximum may be counted at the 1000 level.

Climate and Society (CLSO) Minor

Code	Title	Credits
A minimum of 18 credit hours:		
Required Foundational Courses		
FREC 2124	Forests, Society & Climate (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	3
GEOG 1524	Introduction to Earths Climate (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	3
Subtotal		6
Restricted Electives		
Select one course from four different content areas for a total of three courses: Please note that one of the courses must be at a 3000/4000 level.		9
Physical/Natural Sciences		
CSES 2244	Agriculture, Global Food Security and Health (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 10 - Ethical Reasoning ; Pathways Outcome 11 - Intercultural and Global Awareness)	
FREC 4354	Forest Soil and Watershed Management (Pathways Concept 5 - Quantitative and Computational Thinking (5A) ; Pathways Outcome 11 - Intercultural and Global Awareness) [1]	
GEOS 1064	Climate History: Past, Present, and Future (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 10 - Ethical Reasoning)	
GEOS 3034	Oceanography (Not a Pathways course)	
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Outcome 10 - Ethical Reasoning ; Pathways Outcome 11 - Intercultural and Global Awareness)	
Environment and Ecosystems		
FREC 2004	Forest Ecosystems (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	
GEOG/WATR 2004	Water, Environment, and Society (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 10 - Ethical Reasoning)	
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	
GEOG 3274	Polar Environments (Pathways Concept 1 - Discourse (1A); Pathways Outcome 11 - Intercultural and Global Awareness) [1]	
GEOS 1024	Earth Resources, Society, and Environment (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	
Humans Dimensions and Policy		
FREC/NR/LAR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 10 - Ethical Reasoning ; Pathways Outcome 11 - Intercultural and Global Awareness)	
STS 2444	Global Science and Technology Policy (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	
STS 3334	Energy and Society (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 11 - Intercultural and Global Awareness)	
Methods		
FREC 1004/ GEOG 1084	Digital Planet (Pathways Concept 5 - Quantitative and Computational Thinking (5F) ; Pathways Outcome 10 - Ethical Reasoning)	

FREC 3044	Environmental Data Science (Pathways Concept 5 - Quantitative and Computational Thinking (5A) ; Pathways Outcome 10 - Ethical Reasoning) [1]	
Subtotal		9
Required Capstone		
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework (Pathways Concept 1 - Discourse (1A); Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Outcome 10 - Ethical Reasoning) [1]	3
Total Credits		**18**

[1] Some courses listed on this checksheet may have prerequisites, corequisites or other registration restrictions. Please consult the University Course Catalog or check with your advisor for more information.

Graduation Requirements

NOTES:

Complete a minimum of 18 credit hours.

1. Students must complete 3 credits in each of the two following integrative outcomes: (10) Ethical Reasoning and (11) Intercultural Global Awareness.
2. A minimum cumulative GPA of 2.0 in all courses taken is required to complete this minor.
3. All minor courses must be taken on A - F basis.
4. No more than 50% of the graded course credits required for the Minor may be double-counted in a student's Major.
5. When the need arises, such as due to limited course availability or scheduling conflicts, students enrolled in the minor may contact the College of Natural Resources and Environment Advising Center to request to substitute a minor requirement.

Pathways Core Concepts:
If= Foundational Discourse
Ia = Advanced/Applied Discourse
2 = Critical Thinking in the Humanities
3 = Reasoning in the Social Sciences
4 = Reasoning in the Natural Sciences
5f= Foundational Quantitative and Computational Thinking
5a =Advanced/Applied Quantitative and Computational Thinking 6 = Critique and Practice in Design and the Arts
7 = Critical Analysis of Identity and Equity in the United States
Pathways Integrative Concepts:
IO = Ethical Reasoning
11 = Intercultural and Global Awareness

Community Systems and Engagement (CSE) Minor

The Community Systems and Engagement (CSE) Pathways Minor encourages participation by undergraduate students from all majors. The minor prepares students to address persistent community issues through active citizenship and systems thinking competency. By combining community engagement, service learning, and applied problem solving, the minor creates substantial opportunities for experiential learning.

The Pathways Minor in Community Systems and Engagement requires completion of 18 credit hours as follows:

Code	Title	Credits
Select one of the following:		3
SOC 2034	Diversity and Community Engagement (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Pathways Concept 3 - Reasoning in the Social Sciences ; Intercultural and Global Awareness)	
SPIA 1024	Community Service Learning (Pathways Concept 3 - Reasoning in the Social Sciences ; Ethical Reasoning ; Intercultural and Global Awareness)	
Subtotal		3
Required Minor Courses		
SPIA 2024	Community Systems Thinking (Pathways Concept 3 - Reasoning in the Social Sciences ; Intercultural and Global Awareness)	3
HD 3024	Community Analytics (Pathways Concept 5 - Quantitative and Computational Thinking (advanced); Ethical Reasoning)	3
SPIA 4784	Community Systems Capstone (Pathways Concept 5 - Quantitative and Computational Thinking (advanced); Ethical Reasoning; Intercultural and Global Awareness)	3
Subtotal		9
Elective Courses		
Select two of the following: [1]		6
FREC 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Intercultural and Global Awareness)	
SPIA 4964	Field Work/Practicum (variable credit)	
TA 2404	Introduction to Applied Collaborative Techniques (Pathways Concept 6 - Critique and Practice in Design and the Arts ; Pathways Concept 1 - Discourse (applied); Intercultural and Global Awareness)	
UAP 4954	Study Abroad (variable credit)	
UAP/PSCI 4624	The Washington Semester: Seminar in American Politics and Public Policy	
UAP/PSCI 4644	Washington Semester: Politics, Policy and Administration in A Democracy	
Other courses [2]		
Subtotal		6
Total Credits		**18**

1 Electives should be selected to gain additional exposure to a specific engagement strategy, community, or topic area. Global education, internships, research, or field studies with a community engagement focus are encouraged. Students may also choose courses which satisfy other Pathways to General Education requirements if they have a community engagement component.
2 With pre-approval on the minor director.

Notes:

- No more than 50% of the graded course credits required for the Minor in Community Systems and Engagement may be double-counted by a student toward the requirements of a major.
- A GPA of 2.0 or higher is required in minor.
- Some courses listed on this checksheet have prerequisites. Please consult the University Course Catalog or check with your advisor.

Computer Science (CS) Minor

Code	Title	Credits
CS 1114	Introduction to Software Design (C)	3
or CS 2064	Intermediate Programming in Python	
CS 2114	Software Design and Data Structures (C)	3
MATH 2534	Introduction to Discrete Mathematics	3
CS 2505	Introduction to Computer Organization (C)	3
CS 3114	Data Structures and Algorithms	3
CS 3/4/5XXX	CS Elective	3
CS 3/4/5XXX	CS Elective	3
Total Credits		**21**

Graduation Requirements

Additional Requirements and Comments

1. CS minors must earn at least a "C" (2.0) in CS 1114, CS 2114, and CS 2505
2. Students must have a CS minor GPA of at least 2.0 to successfully complete the minor. The CS minor GPA includes all courses with the CS designator.
3. The following courses are not allowed for CS minor credit: BIT 4164, CS 4944, CS 5044, CS 5045, CS 5046, CS 5904, CS 5944, CS 5974, and CS 5994.
4. The following cross-listed courses are allowed for CS 3/4/5XXX elective credit: BIT 4614, CMDA 3634, CMDA 3654, CMDA 4654, ECE 4424, MATH 3414, MATH 4414, PSCI 4164, STAT 3654, and STAT 4654.
5. To declare the CS minor, a student must be in a degree-granting major and must have completed CS 2114 (C) or CS 2505 (C) or one of their equivalent substitutions listed below.
6. The following substitutions are accepted for the CS minor:
   - CS 1054 (C) will substitute for CS 1114 (C).
   - ECE 2514 (C) will substitute for CS 1114 (C).
   - ECE 3514 (C) will substitute for CS 2114 (C).
   - ECE 2564 (C) will substitute for CS 2505 (C).
   - MATH 3034 will substitute for MATH 2534.
   - CS 5040 will substitute for CS 3114.

Undergraduates Taking Graduate Courses

Students within 2 semesters of graduating and with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department if they have been accepted into the Accelerated Undergraduate/Graduate Program, or by permission of the course instructor and the Department. For students not accepted into the Accelerated Undergraduate/Graduate Program, these courses may not be used on the Plan of Study for a graduate degree.

Consumer Studies (CONS) Minor

Code	Title	Credits
Required Minor Courses		
CONS 2304	Consumer and Family Finances	3
AHRM 2404	Consumer Rights	3
CONS 3504	Resource Management for Individuals and Families	3
Select two of the following:		6
CONS 3404	Consumer Education Strategies	
CONS 4314	Debtor-Creditor Relationships	
CONS 4324	Financial Counseling	
CONS 4404	Consumer Protection	
Subtotal		15
Elective Courses		
Select one of the following:		3
FMD 1204	Clothing and People	
FMD 3024	History of Costume	
RED 2644	Housing and the Consumer	
RED 4604	Environmental and Sustainability Issues in Housing	
Subtotal		3
Total Credits		**18**

Graduation Requirements

Note: A minimum GPA of 2.0 in all courses taken to fulfill the minor is required.
The curriculum includes no hidden pre-requisites.

Crop & Soil Environmental Sciences (CSES) Minor

Code	Title	Credits
Required Minor Courses		
CSES 2444	Agronomic Crops	3
or SPES 2244	World Crops: Food and Culture	
Select one of the following:		3-4
CSES 3114/ GEOS 3614	Soils	
And		
CSES 3124/ GEOS 3624	Soils Laboratory	
Or		
ENSC 3134	Soils in the Landscape	
Subtotal		6-7
Restricted Electives		
Select a minimum of 9 credits of the following:		9
CSES 2244	Agriculture, Global Food Security and Health	
CSES 2224	Foundations of Precision Agriculture	
CSES 2444	Agronomic Crops [1]	
CSES 2564	Turfgrass Management	
CSES 3564	Golf and Sports Turf Management	
CSES 4064	Soil Microbiology	

CSES 4134	Soil Genesis and Classification	
CSES 4144	Plant Breeding and Genetics	
CSES 4214	Soil Fertility and Management	
CSES 4224	Applied Concepts in Precision Agriculture	
CSES 4344	Crop Physiology and Ecology	
CSES 4544	Forage Crop Ecology	
ENSC 3604	Fundamentals of Environmental Science	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC/CHEM 4734	Environmental Soil Chemistry	
ENSC 4244	Ecological Restoration	
HORT 4344	Production of Food Crops in Controlled Environment Agriculture	
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 2244	World Crops: Food and Culture [1]	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Subtotal		9
Optional Restricted Electives		
Select a maximum 4 credits of the following:		3-4
ENT 4254	Insect Pest Management	
ENT/PPWS 4264	Pesticide Usage	
PPWS 4104	Plant Pathology	
Subtotal		3-4
Total Credits		**18-20**

[1] This course can only count once towards the Minor requirements, either as a Required Course or as a Restrictive Elective.

Graduation Requirements

Notes:

- Minimum credits to complete minor =18
- Minimum GPA requirement of 2.0 for courses taken towards the minor
- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor

Cybersecurity (CYBR) Minor

Code	Title	Credits
Required Minor Courses		
Select two of the following:		6
ECE 4560	Computer and Network Security Fundamentals *	
CS 4264	Principles of Computer Security *	
ECE/CS 5560	Fundamentals of Info Security + *	
Subtotal		6
Networks Group		
Select one of the following:		3
ECE 3564	Introduction to Computer Networking	
ECE 4564	Network Application Design	
CS 3754	Cloud Software Development	
CS 4254	Computer Network Architecture and Programming +	
or CS 5565	Network Architecture and Protocols	
Subtotal		3
Systems Group		
Select one of the following:		3
CS 3214	Computer Systems	
CS 4274	Secure Computing Capstone	
CS/ECE 4504	Computer Organization	
or ECE 4530	Hardware-Software Codesign	
or CS 3274	Software Reverse Engineering	
ECE 3574	Applied Software Design	
Subtotal		3
Interdisciplinary Group		
Select one of the following:		3
ACIS 4684	Information Systems Security and Assurance	
BIT 4614	Cybersecurity Management II	
CS 3274	Software Reverse Engineering	
CS/BIT/PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	
CS 4274	Secure Computing Capstone	
FIN 4014	Cyberlaw and Policy	
MATH 4175	Cryptography	
MATH 4176	Cryptography	
Subtotal		3
Additional Required Elective Course (3c)		
Select one additional course from the Networks, Systems, or Interdisciplinary List		3
Subtotal		3
Seminar 1c		
ECE 4944	Cybersecurity Seminar (offered Spring semester only)	1
Subtotal		1
Total Credits		**19**

+ Students in their senior year with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department with the permission of the course instructor and the department head.

* CS 5560/ECE 5560 can be substituted for either ECE 4560 or CS 4264, not both courses.

Graduation Requirements

Additional Requirements

1. The Cybersecurity Minor is restricted to students in the BSEE, BSPCE, and BSCS degree programs only.
2. Students majoring in Secure Computing in Computer Science are not eligible to enroll in the Cybersecurity Minor due to course duplication.
3. To declare the Cybersecurity Minor, a student must be in a degree-granting major and have completed one of the following courses: CS 3214 **or** ECE 3574.
4. It is your responsibility to ensure that you have completed the prerequisites for each course. For prerequisite grade requirements

and the most accurate and up-to-date prerequisite information, please refer to the timetable of classes.

Dairy Science (DASC) Minor

Code	Title	Credits
Required Minor Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
ALS 2304	Comparative Animal Physiology and Anatomy	4
DASC 2474	Dairy Science and Industry	3
DASC 4374	Physiology of Lactation	3
Subtotal		10
Elective Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Complete at least 3 credits at the 3000-4000 level.		
Select a minimum of 9 credits of the following courses:		9
DASC 1574	Dairy Science First Year Experience	
DASC 1464	Dairy Cattle Handling	
DASC 2204	Entrepreneurship in Animal Agriculture	
DASC 2484	Dairy Cattle Evaluation	
DASC/APSC 3134	Animal Agriculture and the Environment	
DASC 3274	Applied Dairy Cattle Nutrition	
DASC 3474	Dairy Information Systems	
DASC 4174	Applied Dairy Cattle Genetics	
DASC 4274	Dairy Ration Formulation	
DASC/APSC 4304	Principles and Practices of Bovine Reproduction	
DASC 4384	Mammary Immunology	
DASC 4474	Advanced Dairy Management Evaluation	
DASC 4475	Dairy Enterprise Management	
DASC 4476	Dairy Enterprise Management	
Subtotal		9
Total Credits		**19**

Graduation Requirements

1. Total 19 credit hours. A minimum of 6 credits at the 3000-4000 level must be completed.
2. Students who minor in Dairy Science must register with the School of Animal Sciences and be assigned a faculty advisor.
3. A minimum 2.0 grade point average across all courses taken in the minor is required for completion of the minor.

Data and Decisions (DTDC) Minor

Code	Title	Credits
I. Introductory Restricted Elective		
Select one of the following:		3
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
CS 1014	Introduction to Computational Thinking (Pathways Concept 5f – Foundational Quantitative and Computational Thinking)	
FREC 1004/ GEOG 1084	Digital Planet (Pathways Concept 5f – Foundational Quantitative and Computational Thinking)	
HIST/SOC/ STS 2604	Introduction to Data in Social Context (Pathways Concept 5f – Foundational Quantitative and Computational Thinking)	
SPIA 2004	Introduction to Urban Analytics	
STAT 1014	Data in Our Lives (Pathways Concept 5f – Foundational Quantitative and Computational Thinking)	
Subtotal		3
II. Core Requirements		
BDS 2005	Fundamentals of Behavioral Decision Science (Pathways Concept 3 - Reasoning in the Social Sciences)	3
CMDA 2014	Data Matter (Pathways Concept 5a – Advanced Quantitative and Computational Thinking)	3
Subtotal		6
III. Restricted Electives - Applying Data and Decisions		
Select two of the following:		6
BDS 2006	Fundamentals of Behavioral Decision Science (Pathways Concept 3 - Reasoning in the Social Sciences)	
BIT 3434	Advanced Modeling for Business Analytics	
BIT 4604	Data Governance, Privacy and Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)	
FREC 3044	Environmental Data Science (Pathways Concept 5a – Advanced Quantitative and Computational Thinking)	
GEOS/GEOG 4354	Introduction to Remote Sensing	
HD 3024	Community Analytics	
HIST 2624	Topics in the History of Data in Social Context (Pathways Concept 1a – Advance Discourse Pathways Concept 2 - Critical Thinking in the Humanities)	
HIST 3774	Digital History	
PHS/HNFE 3634	Epidemiologic Concepts of Health and Disease	
PHS 4064	Modeling Infectious Diseases	
PSCI 2024	Research Methods in Political Science	
SOC/HD 2104	Quantitative Approaches to Community Research (Pathways Concept 5f – Foundational Quantitative and Computational Thinking)	
SOC 3204	Social Research Methods	
STAT 3604	Statistics for Social Science (Pathways Concept 5a – Advanced Quantitative and Computational Thinking)	
UAP 3024	Urban and Regional Analysis	
Subtotal		6
IV. Data and Decisions Capstone Requirement		
BIT/MGT 4854	Analytics in Action (Pathways Concept 1a – Advanced Discourse)	3
Subtotal		3
Total Credits		**18**

Graduation Requirements

Credit Hours Requirement

18 total credit hours are required to complete the minor.

Minimum GPA

For the courses attempted for this minor, the student must have a GPA of 2.0 or better.

Prerequisites

Some courses listed on this checksheet may have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Acceptable Substitutions

CS 1014: CS 1114, or CS 1064, or CS 1054, or CS 1044.

STAT 3604: STAT 3005 or STAT 3615 or CMDA 2005*

**Note: If CMDA 2005 is taken for an Applying Data & Decisions Restricted Elective, 9 credits of Applying Data & Decisions Restricted Electives will be required for the minor, making the total minor requirements 21.*

Design + Technology + Creative Expression (DTCE) Minor

Code	Title	Credits
Required Minor Courses		
IDS 1114	Play to Make	3
MUS 3064	Digital Sound Manipulation	3
AAD 4234	Capstone Collaborations: Cross-Disciplinary Teams	3
Subtotal		9
Elective Courses		
Understand (Empathize/Define)		
Select one of the following:		3
CINE 2054	Introduction to Cinema	
COMM 2084	Media and Society	
CS 3724	Introduction to Human-Computer Interaction	
HIST/SOC/ STS 2604	Introduction to Data in Social Context	
IDS 2114	History of Industrial Design	
IDS 2124	History of Modern Industrial Designers	
ITDS 1114	Design Appreciation	
MUS 3314	Instrumental Ensemble Music	
STS 1504	Introduction to Science, Technology, and Society	
STS 3284	Technology and Disability	
Explore (Ideate/Prototype)		
Select one of the following:		3
AHRM 2014	Design for Consumers Studio	
CS 1014	Introduction to Computational Thinking	
CS 1064	Introduction to Programming in Python	
ENGE 2094	Create!: Ideation & Innovation	
ENGL 2744	Introduction to Creative Writing	
HUM 2204	The Creative Process	
TA 2204	Creative Dance	
IDS 3224	Topics in Design Competencies	
Materialize (Test/Implement)		
Select one of the following:		3
CS 3744	Introduction to GUI Programming and Graphics	
CMST 3274	Social Dimensions of Games, Simulations, and Virtual Environments	
IDS 2044	Human Factors	
MKTG 3104	Marketing Management	
MUS 4014H	Topics Adv Electroacoustic Res	
SOC 2104	Quantitative Approaches to Community Research	
TA 2404	Introduction to Applied Collaborative Techniques	
Subtotal		9
Total Credits		**18**

Graduation Requirements

At least 6 credits should be taken at the 3000-level or above. Students should select electives that are in disciplines not associated with student major.

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Development and International Trade (DAIT) Minor

Code	Title	Credits
I - Required Introductory Courses [1]		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
MATH 1025	Elementary Calculus	3
or MATH 1225	Calculus of a Single Variable	
Subtotal		9
II - Required Core Courses		
AAEC 3004	Agricultural Production and Consumption Economics [2]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [2]	3
AAEC 3324	Environment and Sustainable Development Economics [2]	3
AAEC 3204	International Agricultural Development and Trade [2]	3
AAEC 4324	Rural and Regional Development Policy [2]	3
Subtotal		15
Total Credits		**24**

1. This minor is not available to students majoring in Agribusiness, Applied Economic Management, Environmental Economics: Management & Policy, International Trade and Development or Food and Health Systems Economics.
2. **Pre-requisites**: Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the

Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

Graduation Requirements

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Digital Marketing Strategy (DMS) Minor

Code	Title	Credits
I. Required Minor Courses		
MKTG 3104	Marketing Management	3
MKTG 3164	Introduction to Digital Marketing Strategy	3
MKTG 4154	Marketing Research	3
MKTG 4164	Social Media and Content Marketing	3
MKTG 4204	Consumer Behavior	3
MKTG 4264	Analytics for Marketing	3
Subtotal		18
II. Elective Courses		
Select one course from the list below		3
Subtotal		3
Total Credits		**21**

Elective Course Options

Code	Title	Credits
ART 4534	Topics in Applied Art and Design Studio	3
ART 4504	Topics in Multimedia Studio	3
BIT 3424	Introduction to Business Analytics Modeling	3
BIT 3434	Advanced Modeling for Business Analytics	3
BIT 3444	Advanced Business Computing and Applications	3
BIT 3514	Systems Analysis	3
BIT 3524	Database Management and Design	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4454	Business Analysis Seminar in IT	3
BIT 4474	Global Operations and Information Technology	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries	3
CMST 3064	Persuasion	3
CMST 3124	Interpersonal Communication	3
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics	3
CS/CMDA/STAT 3654	Introductory Data Analytics and Visualization	3
CS 3704	Intermediate Software Design and Engineering	3
CS 3714	Mobile Software Development	3
CS 3724	Introduction to Human-Computer Interaction	3
CS/ECE 4570	Wireless Networks and Mobile Systems	3
CS 4604	Introduction to Data Base Management Systems	3
CS 4644	Creative Computing Studio	3
CS 4784	Human-Computer Interaction Capstone	3
ESM 4015 & ESM 4016	Creative Design and Project and Creative Design and Project	6
HTM 4354	Information Technology and Social Media in Hospitality and Tourism	3
JMC 4264	Social Media Theory and Practice	3
MKTG 3134	Personal Well-being and Professional Success	3
MKTG 3954	Study Abroad	3
MKTG 4114	Introduction to AI in Marketing	3
MKTG 4054	Sales Technology	3
MKTG 4254	Product and Price Management	3
MKTG 4304	Marketing Communications	3
MKTG 4404	Field Practicum in Marketing	3
MKTG 4554	Principles of Professional Selling	3
MKTG 4604	Retail Management	3
MKTG 4974	Independent Study	3
MKTG 4984	Special Study	3
MKTG 4994	Undergraduate Research	1-19
or MKTG 4994H	Honors Undergraduate Research	
SBIO 3124	Paper and Paperboard Packaging	3
SBIO 3445 & SBIO 3446	Entrepreneurial Wood Design and Innovation and Entrepreneurial Wood Design and Innovation	6
SBIO 4024	Packaging Design for Global Distribution	3

Graduation Requirements

Students must complete the minor with at least a 2.00 GPA in the **21 credit hours** required for the minor. If these criteria are met, the minor will be noted on the transcript.

Application Eligibility

Application to the minor in Digital Marketing Strategy is open to all university students, with the exception of Marketing majors, with at least a 2.5 overall GPA at Virginia Tech.

Students can apply for the Digital Marketing Strategy minor at http://pampl.in/addminor

Prerequisites

Students are responsible for ensuring they have met necessary prerequisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Major and Minor Courses

No more than 50% of the graded course credits required for the Minor in Digital Marketing Strategy may be double-counted by a student also enrolled in a non-marketing business degree.

Diversity and Community Engagement (DCE) Minor

Code	Title	Credits
Required Minor Courses		
SOC 2034	Diversity and Community Engagement	3
SOC 4294	Capstone: Diversity Engagement [1]	3
Subtotal		6
Elective Courses for Diversity and Community Engagement Minor		

Select four courses in four of the five area on the approved minor list from the following: [2,3]		12
Area 1: Expressive Cultures		
AFST 2774	Black Aesthetics	
AFST 4774	Blacks in the Performing Arts	
AINS/HUM 2104	Oral Traditions and Culture	
AINS/ENGL 2804	Contemporary Native American Literatures	
AINS/ENGL 3304	The Languages of Native America	
ENGL 3624	Appalachian Literature	
ENGL 3654	Ethnic American Literature	
HUM/RLCL 3204	Multicultural Communication	
RLCL 2324	Islam	
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures	
WGS 2224	Creativity, Power, & Politics	
WGS/RLCL 3014	Women and Gender in Islam	
Area 2: Historical Legacies		
AFST/HIST 2275	African-American History	
AFST/HIST 2276	African-American History	
AFST 2354	The Civil Rights Movement	
AFST 4704	History of African-American Theatre	
AINS/HUM 2104	Oral Traditions and Culture	
HIST 3105 & HIST 3106	Women in U S History and Women in U S History	
HIST 3164	Sexuality in American History	
HIST 3205 & HIST 3206	and	
HIST 3214	History of Appalachia	
PSCI 3784	Origins of the State	
SPAN 2754	Topics in Spanish American Culture	
SPAN 3444	Topics in Early Spanish American Cultures	
Area 3: Global Perspectives		
AINS/PSCI 3684	Indigenous Peoples and World Politics	
ENGL 3644	The Postcolonial Novel	
FR 3314	Introduction to Francophone Studies	
GEOG/IS/PSCI 2034	Geography of Global Conflict	
HIST 3554	Age of Globalization	
IS/GEOG/PSCI 2054	Introduction to World Politics	
IS/GEOG/PSCI 2064	The Global Economy and World Politics	
ISE 4304	Global Issues in Industrial Management	
PHIL 2304	Global Ethics	
STS/HIST 2054	Engineering Cultures	
SOC/GEOG/UAP 4764	International Development Policy and Planning	
WGS 3214	Global Feminisms	
WGS/GEOG/UAP 4214	Gender, Environment, and International Development	
Area 4: Community and Society		
ALCE 4304	Community Education and Development	
AFST/SOC 2454	Race and Racism	
AFST 3454	African American Leadership for Social Change	
APS/AHRM/GEOG/HD/HUM/SOC/UAP 3464	Appalachian Communities	
APS/HUM 4414	Issues in Appalachian Studies	
ECON 3024	Economic Justice	
ECON 4124	Growth and Development	
HD 2314	Human Sexuality	
HD 4364	Gender And Family Diversity	
HTM 3484	Socio-Cultural Impacts of Tourism	
PSCI 3255 & PSCI 3256	The Politics of Race, Ethnicity and Gender and The Politics of Race, Ethnicity and Gender	
PSCI 3724	Poverty and Welfare Policy	
PSYC 2084	Social Psychology	
SOC 2024	Sociology of Race and Ethnicity	
SOC/RLCL 2514	Asian American Experience	
SOC 3004	Social Inequality	
SOC 3014	Gender Relations	
SOC 3504	Population Trends and Issues	
SOC 3614	Gender and Work in the U.S.	
SOC 3714	Sociology of Aging	
TA 4304	Theatre Outreach	
WGS 2254	Feminist Activism	
WGS/AFST/SOC 2264	Race, Class, Gender, and Sexualities	
WGS 2284	Lesbian, Gay, Bisexual, Transgender and Queer Issues	
WGS/STS 4704	Gender and Science	
Area 5: Experiential Learning [4]		
Subtotal		12
Total Credits		**18**

1. Should be taken as the final course for fulfillment of the minor unless granted permission by the instructor.
2. At least 9 hours must be taken at the 3000-4000 level. Alternatively, students may complete three credit hours in three of the five areas, and an additional three credit hours in an approved experiential learning project. This experiential learning project must be approved by the minor director.
3. Additional courses may be substituted for the fulfillment of any of the aforementioned areas at the discretion of the minor advisor. A Course Substitution Form must be submitted. A current syllabus and course description are required for these additional courses to be considered

toward the fulfillment of requirements for the Diversity and Community Engagement Minor.

[4] Experiential learning projects are educational opportunities that occur outside of the confines of a traditional classroom. These projects must include work related to the issues of diversity and community engagement. A student will receive three credit hours for an experiential learning provided they fulfill all of the requirements. Examples of experiential of learning project are, but may not necessarily include the following examples:

- Service learning
- Volunteer projects
- Internships related to diversity or community work
- Undergraduate research projects
- Conflict resolution programs

Experiential Learning Projects will receive credit hours under SOC 4964 Field Study. The minor director must approve all experiential learning projects. Please refer to the Experiential Learning Project Handbook for guidelines and procedures.

Additional Requirements

- Departmental pre-requisites for these courses must be satisfied
- A minimum of 18 credit hours is required
- A maximum of 6 credit hours may be taken within the same program to fulfill the electives requirement. [1]
- A maximum of 6 credit hours may be taken at the 1000-2000 level, including the foundations course.
- All courses must be taken for a letter grade of A/F
- A minimum GPA of 2.0 in all courses taken to fulfill the minor required.

1 Due to the Department of Sociology offering both the foundation and capstone courses, students will be allowed to take one additional course in this department. For the purposes of this minor, Africana Studies, American Indian Studies, and Women and Gender Studies are considered separate programs. Similarly, in the Religion and Culture Department, Religion, Humanities, and Appalachian Studies will be counted as separate programs.

Minor Advisor
Dale Wimberley
wimberley@vt.edu
(504) 231-8960

Early Childhood Development and Education Minor (ECDE)

Code	Title	Credits
Required Minor Courses		
HD 1004	Childhood and Adolescence	3
HD 3214	Infancy and Early Childhood	3
HD 3254	Curriculum in Early Childhood	3
HD 4964	Field Study [1,2]	1
or EDCI 3964	Field Study	
or EDCI 4964	Field Study	
Subtotal		10
Elective Courses		
Community Engagement and Advocacy		
Select one of the following:		3
CMST 3134	Public Advocacy	
ENGL 4804	Grant Proposals and Reports	
HD 3024	Community Analytics	
HD 3234	Child/Youth Community Services	
HD 3304	Advanced Helping Skills	
SOC 2034	Diversity and Community Engagement	
Cognitive, Communicative, and Social Processes		
Select two of the following:		6
EDCI 3234	Foundations of Reading Instruction (PK-6) [3]	
EDCI 3244	Curriculum and Instruction in Elementary Mathematics, PK-3 [3]	
PSYC/ENGL 1524	Language and the Mind	
PSYC 3034	Psychological Disorders of Children	
SOC 3004	Social Inequality	
SOC/ENGL/ RLCL 3144	Language and Ethnicity in the United States	
Subtotal		9
Total Credits		**19**

1 For Human Development Majors, the 1 credit of field study for the ECDE minor must be in addition to the 6 credit hours of field study required for the HD major. Elementary Education Majors pursuing the Virginia State Early childhood for three-year-olds and four-year-olds add-on endorsement should seek information and academic advising from the School of Education (soe@vt.edu) regarding the specific requirements for Field Study.

2 Students who are not majoring in a degree program offered by the School of Education may not enroll in EDCI 3964 or EDCI 4964. Elementary Education Majors pursuing the Virginia State Early childhood for three-year-olds and four-year-olds add-on endorsement should seek information and academic advising from the School of Education (soe@vt.edu) regarding the specific requirements for Field Study.

3 Elementary Education Majors pursuing the Virginia State Early childhood for three-year-olds and four-year-olds add-on endorsement must complete EDCI 3234 and EDCI 3244.

Graduation Requirements

Students cannot major in ECDE and minor in ECDE.
University min. GPA is 2.0. In-minor min. GPA is 2.0. All minor courses count toward the in-minor GPA.
Some courses listed on this checksheet may have prerequisites; see Undergraduate Catalog.
Students participating in the elementary education degree program that grants Virginia State Teaching Licensure have the option of fulfilling the ECDE minor by taking specific minor courses options that will make them eligible for the Virginia State Early childhood for three-year-olds and four-year-olds add-on endorsement. Students seeking this option should seek information and academic advising from the School of Education (soe@vt.edu).

Ecological Cities (ECOC) Minor

Code	Title	Credits
Required Foundational Courses (6 credit hours)		
LAR 1254	Environment and Natural Systems (Pathways Concept 4 - Reasoning in the Natural Sciences ; Pathways Concept 5 - Quantitative and Computational Thinking)	3
HORT/FREC 2134	Plants and Greenspaces in Urban Communities (Pathways Concept 4 - Reasoning in the Natural Sciences)	3
Subtotal		6
Depth Courses (Select one course from each group - 9 credit hours minimum)		**9**
Ecology and Related Sciences		
BIOL 2804	Ecology *	
BSE 3324	Small Watershed Hydrology *	
ENSC 3134	Soils in the Landscape *	
ENSC 3604	Fundamentals of Environmental Science *	
ENSC 4244	Ecological Restoration *	
FREC 2004	Forest Ecosystems (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC 2114	Ecology of Appalachian Forests (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC/WATR 3104	Principles of Watershed Hydrology *	
FREC/HORT 3354	Trees in the Built Environment *	
FREC 3954	Study Abroad (with approval; variable)	
HORT 3454	*	
Humanities and Social Sciences		
ARCH/SPIA 1044	Life in the Built Environment (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
ENGL 3534	Literature and the Environment (Pathways Concept 1 - Discourse; or Pathways Concept 2 - Critical Thinking in the Humanities) *	
GEOG/SPIA 2244	Sustainable Urbanization (Pathways Concept 3 - Reasoning in the Social Sciences) *	
GEOG 3244	The U.S. City	
HIST 3144	American Environmental History (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences)	
LAR 3264	People Community and Place (Pathways Concept 3 - Reasoning in the Social Sciences) *	
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives (Pathways Concept 2 - Critical Thinking in the Humanities) *	
SPIA/HNFE 2314	Active Transportation for a Healthy, Sustainable Planet (Pathways Concept 3 - Reasoning in the Social Sciences)	
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities)	
UAP 3014	Urban Policy and Planning *	
UAP 3354	Introduction to Environmental Policy and Planning	
Design and Practice		
BC 4334	Sustainable Building Performance Management	
BSE 3334	Nonpoint Source Pollution Assessment and Control *	
BSE 4126	Comprehensive Design Project *	
CEE 3274	Introduction to Land Development Design *	
CEE 4264	Sustainable Land Development *	
FREC 4454	Urban and Community Forestry (Pathways Concept 1 - Discourse)	
HORT 4744	Plant Establishment and Environmental Design *	
LAR 4034	Evolution of the American Landscape (Pathways Concept 1 - Discourse ; Pathways Concept 2 - Critical Thinking in the Humanities)	
LAR 4084	Landscape Design and Planning Studio *	
PM 3684	Sustainable Property Management (Pathways Concept 3 - Reasoning in the Social Sciences)	
RED 4604	Environmental and Sustainability Issues in Housing (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
SBIO 3324	Green Building Systems	
UAP 4354	Interdisciplinary Environmental Problem Solving Studio *	
UAP 4394	Community Renewable Energy Systems	
Subtotal		9
Required Capstone Course		
FREC/BSE/HORT/LAR/SPIA 4554	Creating the Ecological City (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 6 - Critique and Practice in Design and the Arts) *	3
Total Credits		**18**

* Some courses in the Minor Requirements listed above may have prerequisites, corequisites, or other registration requirements. Please see the University Course Catalog or Timetable for more information.

Graduation Requirements

Notes for Ecological Cities Pathways Minor:

A minimum of 18 credit hours is required to graduate with an Ecological Cities minor.

1. Any course substitutions requests of the courses above must be proposed in writing to the College of Natural Resources and Environment Advising Center in 138 Cheatham Hall.
2. A minimum GPA of 2.0 in courses comprising the minor is required to complete the minor.

Steps for completing the Ecological Cities Minor

1. Make an advising appointment with the ECOC Minor Coordinator for orientation to the minor.
2. Declare the Ecological Cities minor at the CNRE Advising Center in 138 Cheatham Hall.

3. Include minor information when updating the application for degree in Hokie Spa.
4. Students cannot graduate until they have either (i) satisfied the requirements for the minor or (ii) withdrawn from the minor by notifying CNRE Advising Center office in 138 Cheatham Hall and revising their DARS.

Economics (ECAS) Minor

Code	Title	Credits
Required Minor Courses		
Principles of Economics Sequence		
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	6
Intermediate Theory Courses		
ECON 3104 & ECON 3204	Microeconomic Theory and Macroeconomic Theory	6
Subtotal		12
Elective Courses		
3000 or 4000 level Economics elective		3
3000 or 4000 level Economics elective		3
Subtotal		6
Total Credits		**18**

Graduation Requirements

- The required GPA for the minor is 2.0. All economics courses count in computation of GPA, not just the best 18 hours.
- ECON 4754 Internships, ECON 4964 Field Study, ECON 4974 and ECON 4974H Independent Study do not count as ECON Electives.

Economics of Diversity, Equity, and Inclusion Minor

Code	Title	Credits
A student majoring in Economics or any option in Economics cannot complete this minor.		
1. Introduction/Foundational Experience Required Courses		
Select two of the following		6
ECON 1104	Economics of Gender	
ECON 1204	Economics of Race	
ECON 1214	Economic History of Diversity and Inclusion	
Subtotal		6
2. Mid-Level Experience		
I. Introduction to Identity, Diversity, and Society		
Select one of the following:		3
AINS 1104	Introduction to American Indian Studies (Pathways Concept 3 - Reasoning in the Social Sciences)	
APS/HUM 1704	Introduction to Appalachian Studies (Pathways Concept 2 - Critical Thinking in the Humanities)	
ARBC 2774	Arab Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences)	
CHN 2734	Chinese Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities)	
HD 1134	Introduction to Disabilities Studies (Pathways Concept 2 - Critical Thinking in the Humanities)	
HIST 2275	African-American History	
HIST/CRIM 2504	Crime and Punishment in American History	
HIST/AINS 3174	Native American History	
MGT 3444	Multicultural Diversity in Organizations	
PHIL 2314	Philosophy of Sex, Gender, and Race	
PSCI 3255	The Politics of Race, Ethnicity and Gender	
RLCL 1024/1024H	Judaism, Christianity, and Islam (Pathways Concept 2 - Critical Thinking in the Humanities)	
RLCL 1904/1904H	Religion and Culture In Asia (Pathways Concept 2 - Critical Thinking in the Humanities)	
RLCL 2124	Religion in American Life	
RLCL/JUD 2134	Judaism: A Survey of History, Culture, and Heritage (Pathways Concept 2 - Critical Thinking in the Humanities)	
RLCL/SOC 2514	Asian American Experience (Pathways Concept 3 - Reasoning in the Social Sciences)	
RLCL/HUM 3204	Multicultural Communication	
RLCL 3214	Religion and Culture in India (Pathways Concept 2 - Critical Thinking in the Humanities)	
RLCL 3224	Religion and Culture in China and Japan (Pathways Concept 2 - Critical Thinking in the Humanities)	
SOC 2004	Social Problems (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
SOC 2024	Sociology of Race and Ethnicity	
SOC 2034	Diversity and Community Engagement	
SPAN 2764	Introduction to Latino American Studies (Pathways Concept 2 - Critical Thinking in the Humanities)	
STS 2034	Introduction to Technology and Race (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
STS/APS 3124	Societal Health in North America	
STS 3284	Technology and Disability (Pathways Concept 2 - Critical Thinking in the Humanities)	
WGS 1824	Introduction to Womens and Gender Studies (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences)	
WGS 2284	Lesbian, Gay, Bisexual, Transgender and Queer Issues	
II. Analysis		
Select one of the following:		3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
HIST/STS/ SOC 2604	Introduction to Data in Social Context	
STAT 3005	Statistical Methods	
STAT 3615	Biological Statistics	

STAT 3604	Statistics for Social Science	
III. Writing Course		
Select one of the following:		3
AINS 2414	Identity and Inclusion in Agricultural and Life Sciences	
ENGL 2634	Writing and Social Justice	
ENGL 2844	Introduction to Professional and Technical Writing	
ENGL 3754	Advanced Writing and Research	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
ENGL 3834	Intercultural Issues in Professional Writing	
HUM 2504	Introduction to American Studies	
Subtotal		9
3. Capstone		
Select one of the following:		3
ECON 4964	Field Study [1]	
ECON 4974/4974H	Independent Study [1]	
ECON 4984	Special Study [1]	
ECON 4994/4994H	Undergraduate Research	
Subtotal		3
Total Credits		**18**

[1] ECON 3004, ECON 4964, ECON 4974, and ECON 4984 may be used for requirements with approval from the department prior to the start of the semester in which the course is completed.

Graduation Requirements

1. All courses to fulfill minor must be taken A/F.
2. The minor requires a minimum GPA of 2.0. Six credit-hours must be completed at the 3000-4000 level.

Ecosystem for Human Well-Being (EHWB) Minor

Code	Title	Credits
Required Minor Courses		
ENSC 1015	Foundations of Environmental Science	3
HIST 3144	American Environmental History	3
PHS 4054	Concepts in One Health (Junior Standing for Capstone Experience Required Course)	3
Subtotal		9
Elective Courses		
Select one course from each of the three following areas:		9
Environment		
AAEC 3324	Environment and Sustainable Development Economics	
ENGL 3534	Literature and the Environment	
or ENGL 110	First-Year Writing	
or ENGL 120		
or COMM 10	Communication Skills	
FREC 2004	Forest Ecosystems	
FREC 2124	Forests, Society & Climate	
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 3104	Environmental Justice, Resources and Development	
STS 3334	Energy and Society	
Health		
CSES 2244	Agriculture, Global Food Security and Health	
ENGL 3154	Literature, Medicine, and Culture	
GEOG 4074	Medical Geography of Infectious Diseases	
HIST 3724	History of Disease, Medicine, and Health	
HNFE 2664	Behavioral Theory in Health Promotion	
PHS 3014	Introduction to Environmental Health	
PSYC 3024	Human Behaviors and Natural Environments	
Culture		
AINS 1104	Introduction to American Indian Studies	
APS/HUM 1704	Introduction to Appalachian Studies	
ENGL 2634	Writing and Social Justice	
HORT/FREC 2134	Plants and Greenspaces in Urban Communities	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HTM 3484	Socio-Cultural Impacts of Tourism	
STS 1504	Introduction to Science, Technology, and Society	
Subtotal		9
Total Credits		**18**

Graduation Requirements

Minimum Credits for the Minor: 18 credit hours to include 9 required courses and 9 restricted elective credits.

Minimum GPA requirements: Must have a 2.0 or higher for all courses used to complete this minor.

Prerequisites: Some courses in the minor requirements have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Steps for Completing the Minor:

1. To add the minor complete the online form found on the CALS Student Forms Page (https://www.cals.vt.edu/academic-programs/current/CALS_Studentforms.html)
2. Students cannot graduate until they have either satisfied the requirements for the minor or withdrawn from the minor.

From more information contact Dr. Matthew Eick (540) 231-8943, eick@vt.edu or Renee Eaton (540) 231-5987, rselberg@vt.edu

Engineering Science & Mechanics (ESM) Minor

Code	Title	Credits
1. Required Minor Courses		
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3

Subtotal		9
2. Fluid Mechanics Requirement		
Select one of the following: [1]		3-4
ESM 3234	Fluid Mechanics I-Control Volume Analysis	
ESM 3024	Introduction to Fluid Mechanics	
ME 3414	Fluid Dynamics [1]	
CEE 3304	Fluid Mechanics for Civil and Environmental Engineering [1]	
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers [1]	
Subtotal		3-4
3. Approved Electives		
Select six credits from the Approved Electives List		6
Subtotal		6
4. Approved ESM Research or Graduate Level Education		
Select 3 credits from Senior Design Courses or Departmental Undergraduate Research courses. The following will automatically fulfill this requirement. [2,3]		3
AOE 4065	Air Vehicle Design	
AOE 4066	Air Vehicle Design	
AOE 4165	Space Vehicle Design	
AOE 4166	Space Vehicle Design	
AOE 4994	Undergraduate Research	
BMES 4015	BME Senior Design and Project	
BMES 4016	BME Senior Design and Project	
BMES 4994	Undergraduate Research	
CEE 4104	Water and Wastewater Treatment Design	
CEE 4274	Land Development Design	
CEE 4334	Hydraulic Structures	
CEE 4544	Design of Earth Structures	
CEE 4654	Geometric Design of Highways	
CEE 4664	Pavement Design	
CEE 4994	Undergraduate Research	
ESM 4994	Undergraduate Research	
ME 4015	Engineering Design and Project	
ME 4016	Engineering Design and Project	
ME 4994	Undergraduate Research	
MSE 4075	Senior Design Laboratory	
MSE 4076	Senior Design Laboratory	
MSE 4994	Undergraduate Research	
Subtotal		3
Total Credits		**21-22**

1. Students taking a non-ESM course to satisfy Item 2 must take an additional 3 credit hours of ESM coursework from Item 3.
2. Any 3 credit 5000 or 6000 level ESM class may be substituted for any elective in Item 3 and/or the Research Requirement of Item 4. ESM 5004 Scientific Communication in Engineering Mechanics and/or ESM 5944 Seminar may not be counted.
3. The research requirement may be fulfilled through Senior Design Courses or through a departmental undergraduate research course. Research must demonstrate application of fundamental Engineering Science & Mechanics principles. Similar courses with different department prefixes may count with permission.

Approved Electives List for Item 3

Complete six credits. At least 3 credits must be at 4XXX or above.[1]

Code	Title	Credits
Solid Mechanics		
ESM/MSE 3054	Mechanical Behavior of Materials	3
ESM/MSE 3064	Mechanical Behavior of Materials Laboratory	1
ESM 4024	Advanced Mechanical Behavior of Materials	3
ESM 4044/ CEE 4610	Mechanics of Composite Materials	3
ESM 4444/ AOE 4054	Stability of Structures	3
Fluid Mechanics		
ESM 3334	Fluid Mechanics II-Differential Analysis	3
Dynamics		
ESM 3124	Dynamics II- Analytical and 3-D Motion	3
ESM 4114/ AOE 4514	Nonlinear Dynamics and Chaos	3
Biomechanics		
ESM 4105	Engineering Analysis of Physiologic Systems	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4204	Musculoskeletal Biomechanics	3
ESM 4224	Biodynamics and Control	3
ESM 4234	Mechanics of Biological Systems	3
ESM 4245	Mechanics of Animal Locomotion	3
ESM 4246	Mechanics of Animal Locomotion	3
ESM 4304	Hemodynamics	3
Modeling and Optimization		
ESM/AOE 4084	Engineering Design Optimization	3
ESM/ME 4194	Sustainable Energy Solutions for a Global Society	3
ESM/BMES 4614	Probability-Based Modeling, Analysis, and Assessment	3
ESM 4734/ AOE 4024	An Introduction to the Finite Element Method	3

1. Any 3 credit 5000 or 6000 level ESM class may be substituted for any elective in Item 3 and/or the Research Requirement of Item 4. ESM 5004 Scientific Communication in Engineering Mechanics and/or ESM 5944 Seminar may not be counted.

Graduation Requirements

To obtain a minor in ESM students must:

- complete 21 credit hours of ESM courses on an A-F basis
- earn an in-minor GPA of a 2.0
- earn a minimum of a C- in each course
- obey all prerequisite rules; some courses have prerequisites not required for the minor.

English - Creative Writing (CENG) Minor

Code	Title	Credits
Foundational		
ENGL 2744	Introduction to Creative Writing	3
Subtotal		3
Advanced Creative Writing Courses		
Select four of the following:		12
ENGL/TA 3315	Playwriting	
ENGL 3704	Creative Writing: Fiction [1]	
ENGL 3714	Creative Writing: Poetry [1]	
ENGL 3724	Creative Writing: Creative Non-fiction [1]	
ENGL 3734	Community Writing	
ENGL 3734H	Community Writing	
ENGL 4724	Creative Writing: Fiction for Young People	
Subtotal		12
Literature		
Select one of the following:		3
RLCL/ENGL 3024	Religion and Literature	
ENGL 3534	Literature and the Environment	
ENGL 3544	Literature and Cinema	
ENGL 3644	The Postcolonial Novel	
ENGL 4444	The British Novel	
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4664	Contemporary Fiction	
Subtotal		3
Total Credits		**18**

[1] These courses may be repeated twice for credit (for a total of nine hours).

Graduation Requirements

In order to graduate with a Minor in English: Creative Writing, students must achieve a cumulative GPA of 2.0 in the Minor.

ENGL 1105, ENGL 1106, and ENGL 1204H do not count toward satisfaction of the Minor.

Entomology (ENT) Minor

Code	Title	Credits
Required Minor Courses		
ENT 3014	Insect Biology	2
ENT 3024	Insect Biology Laboratory	2
Select at least three of the following, two of which must have a laboratory class:		10-12
ENT 2004	Insects and Human Society [1]	
ENT 2254	Bees and Beekeeping	
ENT 2264	Bees and Beekeeping Laboratory	
ENT 2804	Bees: Biology, Diversity, and Sustainability [1]	
ENT 3254	Medical and Veterinary Entomology	
ENT 3264	Medical and Veterinary Entomology Laboratory	
ENT 4254	Insect Pest Management	
ENT 4264	Pesticide Usage	
ENT 4354	Aquatic Entomology	
ENT 4484	Freshwater Biomonitoring	
ENT 4624	Animal and Plant Biosafety and Biosecurity	
ENT 4994	Undergraduate Research (up to 3 credits)	
Subtotal		14-16
Elective Courses		
Select one of the following:		3-5
AAEC 3314	Environmental Law	
AAEC 3604	Agricultural Law	
BCHM 4204	Biochemical Toxicology	
BIOL 2804	Ecology	
BIOL 3454	Introductory Parasitology	
BIOL 4004	Freshwater Ecology	
BIOL 4454	Invertebrate Zoology	
BIOL 4474	Ethology	
BIOL 4664	Virology	
BIOL 4674	Pathogenic Bacteriology	
ENGL 3764	Technical Writing	
ENSC 3604	Fundamentals of Environmental Science	
FIW 4454	Human-Wildlife Conflicts	
FIW 4614	Fish Ecology	
FREC 3354	Trees in the Built Environment	
FREC 4514	Forest and Tree Pest Management	
PPWS 4104	Plant Pathology	
PPWS 4504	Fundamentals of Plant Physiology	
STAT 3005 & STAT 3006	Statistical Methods and Statistical Methods	
STAT 3615 & STAT 3616	Biological Statistics and Biological Statistics	
Subtotal		3-5
Prerequisites may be required for above courses. See course catalog or consult your advisor.		
Total Credits		**17-21**

[1] Pathways Course

Graduation Requirements

Total credits required for Entomology Minor = 19

A 2.0 GPA across all courses taken in the minor is required for graduation.

Entrepreneurship - New Venture Growth (ENVG) Minor

Code	Title	Credits
1. Required Minor Courses		
MGT 2064	Foundations of Entrepreneurship	3
MGT 3064	Cornerstones of Entrepreneurship and Innovation	3
MGT 4064	Developing Entrepreneurial Ventures	3

Subtotal		9
2. Select One of the Following Courses - (each is three credits)		
Select one of the following:		3
MGT 3074	Social Entrepreneurship	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development	
MGT 3094	Global Entrepreneurship	
Subtotal		3
3. Restricted Electives		
Select two of the following: [1]		6
AAEC 3454	Small Business Management and Entrepreneurship	
AAEC 4404	Agricultural Management and Problem-solving	
ACIS 4214	Cost Planning and Control [2]	
BIT 3414	Operations and Supply Chain Management [2]	
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries [2]	
CMDA/CS/ STAT 3654	Introductory Data Analytics and Visualization	
CS 4244	Internet Software Development [2]	
CS 4624	Multimedia, Hypertext and Information Access	
CS 4644	Creative Computing Studio [2]	
CS 4704	Software Engineering Capstone [2]	
ENGE/IDS/ MGT 4094	Startup: Commercialization of Innovation	
ENGL 4814	Developing Online Content	
FIN 3054	Legal and Ethical Environment of Business [2]	
FIN 3074	Legal, Ethical, and Financing Issues for Entrepreneurs [2]	
FIN 3104	Introduction to Finance [2]	
FIN 4234	Venture Capital and Investment Banking	
HTM 3244	Franchising and Ownership in the Services Industries	
HTM 3424	Event Management	
IDS 4044	Professional Practice and Entrepreneurship	
ISE 4015	Management Systems Theory, Applications, and Design [2]	
ISE 4304	Global Issues in Industrial Management [2]	
MGT 1064	Entrepreneurs Residence Experience	
MGT 2114	Principles of Project Management	
MGT 2504	Sustainable Business Management	
MGT 3074	Social Entrepreneurship (if not taken to satisfy requirement in section 2)	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development (if not taken to satisfy requirement in section 2)	
MGT 3094	Global Entrepreneurship (if not taken to satisfy requirement in section 2)	
MGT 3164		
MGT 3304	Management Theory and Leadership Practice	
MGT 3754	Management Internships and Career Development [3]	
MGT 3954	Study Abroad [3]	
MGT 4084	Management Consulting	
MGT 4954	Study Abroad [3]	
MGT 4964	Field Study [3]	
MKTG 3104	Marketing Management [2]	
MKTG 4254	Product and Price Management [2]	
MKTG 4304	Marketing Communications [2]	
MKTG 4354	Marketing Channels and Logistics [2]	
MKTG 4454	Sales Force Management [2]	
SBIO 2104	Principles of Packaging	
SBIO 2614	Introduction to Forest Products Marketing	
SBIO 3004	Sustainable Nature-Based Enterprises	
SBIO 3445	Entrepreneurial Wood Design and Innovation	
SBIO 3446	Entrepreneurial Wood Design and Innovation	
SBIO 3454	Society, Sustainability Biomaterials and Energy	
SBIO 3464	Sustainable Operations Management	
SBIO 3554	Sustainable Biomaterials Enterprises	
Subtotal		6
Total Credits		**18**

[1] Cross listed or jointly offered courses can only be taken once to count as credit towards the minor.
[2] May require department approval.
[3] Will only be accepted for the minor when the topic is "Entrepreneurship".

Graduation Requirements

To complete the Entrepreneurship – New Venture Growth Minor, students accepted in the minor must **complete the 18 hours of required and elective courses** listed in sections 1, 2, and 3 **with a minimum average GPA of 2.0**. If these criteria are met the minor will be noted on the student's transcript.

Application Eligibility

Application to the Minor in Entrepreneurship – New Venture Growth (ENVG) is open to all university students in good academic standing pursuing a non-Pamplin Major (Students pursuing any Real Estate major are eligible for the ENVG minor). Admission will be competitive and will be based on the following criteria:

- Minimum 2.00 overall GPA;
- Completion of two Pathway courses or admission to the Innovate living-learning community;
- Written statement of interest in the entrepreneurial purpose associated with new venture growth (not to exceed 1 page);

Students can apply for the ENVG minor here: http://pampl.in/addminor (http://pampl.in/addminor/)

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Environmental Economics (EECO) Minor

Code	Title	Credits
I - Required Introductory Courses [1]		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
MATH 1025	Elementary Calculus	3
or MATH 1225	Calculus of a Single Variable	
Subtotal		6
II - Required Core Courses		
AAEC 3004	Agricultural Production and Consumption Economics [2]	3
AAEC 3324	Environment and Sustainable Development Economics [2]	3
AAEC 3314	Environmental Law	3
AAEC 4314	Environmental Economic Analysis and Management [2]	3
Subtotal		12
III - Electives Credits		
AAEC Elective (must be at the 3000 or 4000 level)		3
AAEC Elective (must be at the 3000 or 4000 level)		3
Subtotal		6
Total Credits		**24**

[1] This minor is not available to students majoring in Agribusiness, Applied Economic Management, Environmental Economics: Management & Policy, International Trade and Development or Food and Health Systems Economics.

[2] **Pre-requisites**: Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

Graduation Requirements

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Environmental Policy and Planning (EPP) Minor

EPP Minor Requirements

Code	Title	Credits
UAP 1024	Leadership, Service, and Public Problem Solving	3
SPIA 2554	Collaborative Policy-Making and Planning	3
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 3014	Urban Policy and Planning	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3
Total Credits		**21**

Graduation Requirements

In-minor GPA: Students must have a 2.0 or above in-minor GPA to complete the SSC minor. All courses listed below are used in the computation of the in-minor GPA.

Intra-SPIA Program majoring and minoring: No more than 50% of the graded course credits required for the Minor in Environmental Policy and Planning may be double-counted by a student also enrolling in a major under the Bachelor of Arts in Public and Urban Affairs.

Prerequisite Statement: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Environmental Science (ENSC) Minor

Code	Title	Credits
Required Minor Courses		**6-7**
CSES 3114/ GEOS 3614	Soils (Courses cross listed with GEOS 3614 and 3624)	
And		
CSES 3124/ GEOS 3624	Soils Laboratory	
Or		
ENSC 3134	Soils in the Landscape	
ENSC 3604	Fundamentals of Environmental Science	
Subtotal		6-7
Restricted Electives		**9**
Select minimum: 9 credits of the following, 6 or more from courses beginning with CSES/ENSC)		
BSE 3324	Small Watershed Hydrology	
BSE 3334	Nonpoint Source Pollution Assessment and Control	
BIOL 2804	Ecology	
BIOL 4004	Freshwater Ecology	
BIOL 4334	Chemical Ecology	
BIOL/ENT 4354	Aquatic Entomology	
CEE 3104	Introduction to Environmental Engineering	
CHEM 4514	Green Chemistry	
CSES/GEOG/ GEOS 3304	Geomorphology	
CSES 3614	Soil Physical and Hydrological Properties	
CSES 4134	Soil Genesis and Classification	
CSES/ENSC/ CHEM 4444	Managed Ecosystems, Ecosystem Services, and Sustainability	
CSES 4854	Wetland Soils and Mitigation	
ENSC 3634	Physics of Pollution	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC/BIOL 4164	Environmental Microbiology	
ENSC 4244	Ecological Restoration	
ENSC 4314	Water Quality	
ENSC/CHEM 4734	Environmental Soil Chemistry	
ENSC 4764	Bioremediation	

ENSC 4774	Reclamation of Drastically Disturbed Lands	
FREC/WATR 3754	Watersheds and Water Quality Monitoring	
FREC 4354	Forest Soil and Watershed Management	
FREC 4374	Forested Wetlands	
FREC 4784	Wetland Hydrology and Biogeochemistry	
FIW 4434	Wildlife Habitat Ecology and Management	
FIW 4534	Ecology and Management of Wetland Systems	
GEOS 4634	Environmental Geochemistry	
GEOS 4804	Groundwater Hydrology	
Subtotal		9
Optional Restricted Electives		
Select maximum 6 credits of the following:		6
AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics	
AAEC 4314	Environmental Economic Analysis and Management	
UAP/PSCI/IS 3344	Global Environmental Issues: Interdisciplinary Perspectives	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
UAP 4374	Land Use and Environment: Planning and Policy	
Subtotal		6
Total Credits		**21-22**

Graduation Requirements

Minimum Credits to Complete the Minor: 21 Total Credits

Minimum GPA Requirement of 2.0 for courses taken towards this minor

Perquisites: Some courses listed for this minor may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

European Engagement (EURE) Minor

Code	Title	Credits
Required Minor Courses		
IS/PSCI 3804	European Integration	3
IS/PSCI 3814	The European Union: Institutions and Policies	3
Subtotal		6
Elective Courses		
Select 12 hours of the following:		12
IS 2964	Field Study (var)	
IS 3944	International Enrollment	
IS 3944S	International Enroll Special 3	
IS 3944T	International Enroll Special 4	
IS 3954	Study Abroad (var)	
IS/PSCI 4034	Topics in Diplomacy Lab	
IS 4134	Capstone Research Project in European Studies	
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop	
IS 4754	Internship (var)	
IS 4964	Field Study (var)	
IS 4994	Undergraduate Research (var)	
Subtotal		12
Total Credits		**18**

Graduation Requirements

Hours Requirement: A minimum of eighteen (18) credit hours is required to graduate with a minor in European Engagement.

In major GPA: GPA of 2.0 is required for the minor. All courses listed are included in the minor GPA calculation.

Maximum number of credit hours: For the following courses the maximum number of credits that can be awarded are as follows: 3944/3944S/3944T (12); 3954 Study Abroad (12); 4034 Diplomacy Lab (9); 4754 Internship (9); 4964 Field Study/Practicum (6) 4994 Undergraduate Research (9).

Use of Courses: No more than 50% of the graded course credits required for the Minor in European Engagement (EURE) may be double-counted in a student's Major.

Course content: To count for the Minor in European Engagement the location or the content/topic of all courses should be European in character. Courses will be evaluated and approved by the International Studies Program advisor.

European Studies (EUST) Minor

Code	Title	Credits
Required Minor Courses		
IS 1104	Introduction to European Studies	3
IS/PSCI 3804	European Integration	3
IS/PSCI 3814	The European Union: Institutions and Policies	3
Subtotal		9
Elective Courses		
Select 9 credit hours of the following:		9
Arabic (ARBC):		
ARBC 2774	Arab Culture and Civilization	
Economics (ECON):		
ECON/PSCI/IS 3914	European Economics	
French (FR):		
FR 2714	Introduction to French Culture and Civilization	
German (GER):		
GER 2724	Introduction to German Culture and Civilization	
History (HIST):		
HIST 1026	Introduction to European History	
HIST 2124	Topics and Critical Issues in World History	
HIST 3364	The Age of Revolution and Napoleon	
HIST 3374	French Empire	
HIST 3394		
HIST 3484	Nazi Germany: History and Memory	
HIST 3614	Imperial Russia	
HIST 3644	Twentieth-Century Russia	
HIST 3684		
International Studies (IS):		
IS/PSCI 2104	Europe Country Analysis	
IS 3116	Selected World Problems [1]	

	IS/PSCI 3824	European Union's Foreign and Security Policy
	IS/PSCI 3825	European Union's Foreign Relations
	IS/PSCI 3826	European Union's Foreign Relations
	IS/PSCI 3834	European Security Governance
	IS/PSCI 3854	European Political Economy
	IS/PSCI/MGT 3874	The European Business Environment
	IS/SOC/RLCL 3884	Culture and Society in Contemporary Europe
	IS/PSCI/ECON 3914	European Economics
	IS 3944	International Enrollment [2]
	IS 3944S	International Enroll Special 3 [2]
	IS 3944T	International Enroll Special 4 [2]
	IS 3954	Study Abroad (var) [2]
	IS/PSCI 4034	Topics in Diplomacy Lab [2]
	IS 4104	Topics in European Studies [1]
	IS 4114	Topics in European Union Policies [1]
	IS 4124	Topics in European Integration [1]
	IS 4134	Capstone Research Project in European Studies
	IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop [2]
	IS 4964	Field Study (var) [2]
	IS 4994	Undergraduate Research (var) [2]
Management (MGT):		
	MGT/PSCI/IS 3874	The European Business Environment
Philosophy (PHIL):		
	PHIL/PSCI 3016	Political Theory
Political Science (PSCI):		
	PSCI/PHIL 3016	Political Theory
	PSCI 3515	European Political Systems
	PSCI 3516	European Political Systems
	PSCI 3524	Politics of Post-Communist Systems
	PSCI 3626	US-Russia Foreign Policies
Religion & Culture (RLCL):		
	RLCL/SOC/IS 3884	Culture and Society in Contemporary Europe
Russian (RUS):		
	RUS 2734	Introduction to Russian Culture and Civilization
Sociology (SOC):		
	SOC/IS/RLCL 3884	Culture and Society in Contemporary Europe
Spanish (SPAN):		
	SPAN 2744	Topics in Spanish Culture
Subtotal		9
Total Credits		**18**

[1] Topics courses can be taken up to three times (9 credit hours).

[2] To count for the Minor EUropean Studies the location of the content/topic of all experiential learning courses (marked with an asterisk) should be European in character. Those courses will be evaluated and approved by the International Studies Program advisor.

Graduation Requirements

Hours Requirement: A minimum of eighteen (18) credit hours is required to graduate with a Minor in EUropean Studies (EUST).

In Major GPA: GPA of 2.0 is required for the minor. All courses listed on this checksheet are included in the minor GPA calculation.

Prerequisites: Some courses listed on this checksheet may have pre-/corequisites; please consult the University Catalogor check with your advisor.

Use of Courses: No more than 50% of the graded course credits required for the Minor in EUropean Studies (EUST) may be double-counted in a student's Major.

Event & Experience Management (EEMG) Minor

Code	Title	Credits
Required Foundation Courses		
HTM 3424	Event Management (Pathways Concept 6 - Critique and Practice in Design and the Arts , 6D)	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism (Pathways Concept 5 - Quantitative and Computational Thinking , 5A)	3
Select one of the following:		3
HTM 2464	Designing the Service Experience (Pathways Concept 3 - Reasoning in the Social Sciences)	
HTM 3484	Socio-Cultural Impacts of Tourism (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
SOC 2034	Diversity and Community Engagement (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
Subtotal		9
Elective Courses		
Select one of the following tracks:		6
Event Sales Track		
Event Management Track		
Subtotal		6
Required Capstone Course		
HTM 4434	Event and Experience Management Senior Workshop (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
Subtotal		3
Total Credits		**18**

Tracks

Choose **one** of the following tracks and complete 6 credit hours from the listed electives.

Event Sales Track

Code	Title	Credits
HTM 2434	Hospitality Sales	3
HUM/RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences)	3
MKTG 4454	Sales Force Management	3
MKTG 4554	Principles of Professional Selling	3
PR 2044	Principles of Public Relations (Pathways Concept 3 - Reasoning in the Social Sciences)	3

Event Management Track

Code	Title	Credits
ALCE 3004	Educational Programs in Agricultural and Life Sciences	3
ALCE/EDCT 4034	Methods of Planning Education Programs for Agriculture	3
ALCE/EDCT 4884	Youth Program Management	3
HTM 2454	Global Travel & Tourism Management (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HTM 2474	Introduction to Meetings and Convention Management	3
HTM 2514	Catering Management	3
HTM 3044	Private Club Management	3
HTM 4444	Winery Tourism	3
ITDS 1114	Design Appreciation (Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A or 6D)	3
LDRS 1414	Citizen Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	3
LDRS 3104	The Dynamics of Leadership	3
LDRS 3304	Elements of Team Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PSYC 2044	Psychology of Learning (Pathways Concept 3 - Reasoning in the Social Sciences)	3

Graduation Requirements

In addition to fulfilling the requirements of their individual majors, students must complete the minor with at least a 2.0 GPA in the 18 credit hours required by the minor. If these criteria are met, the minor will be noted on the student's transcript.

Application Eligibility

The minor in Event and Experience Management (EEMG) is open to all Virginia Tech students with a GPA of at least 2.50 and who have at least 12 earned credit hours here at Virginia Tech.

Students can apply for the EEMG minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Students **cannot** pursue the EEMG Major and Minor simultaneously.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Finance (FIN) Minor

Code	Title	Credits
Required Minor Courses		
ACIS 2115	Principles of Accounting [3]	3
ACIS 2116	Principles of Accounting [1,3]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [2,3]	3
ECON 2005	Principles of Economics [3]	3
FIN 3134	Financial Analytics [4]	3
FIN 3144	Investments: Debt, Equity and Derivatives [4]	3
FIN 3154	Corporate Financial Analytics and Strategy [4]	3
Subtotal		21
Elective Courses		
Select two of the following:		6
FIN 3114	Python/SQL for Data Analytics and Finance	
FIN 4144	International Financial Management	
FIN 4154	Real Estate Finance	
FIN 4224	Fixed Income Securities: Analysis and Management	
FIN 4234	Venture Capital and Investment Banking	
FIN 4244	Asset Valuation and Corporate Governance	
FIN 4264	Managing Risk with Derivatives	
FIN 4274	Equity Securities: Analysis and Management	
Subtotal		6
Total Credits		**27**

1. ISE 3004 Industrial Cost Control may be substituted for ACIS 2116 Principles of Accounting.
2. STAT 3005 Statistical Methods + STAT 3006 Statistical Methods, STAT 3604 Statistics for Social Science, STAT 4705 Probability and Statistics for Engineers + STAT 4706 Probability and Statistics for Engineers, or ISE 2024 Probability Foundations for Industrial and Systems Engineers + STAT 4706 Probability and Statistics for Engineers may be substituted for BIT 2405 Introduction to Business Statistics, Analytics, and Modeling.
3. Students must achieve a grade of C- or higher in ACIS 2115 Principles of Accounting, ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics.
4. Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

Graduation Requirements

Admission Requirements

In order to apply for a minor in Finance, students must:

- Be enrolled in a degree granting program outside the Pamplin College of Business. (Real Estate for Commercial Properties & Real Estate for Residential Properties majors not double majoring in a business degree are eligible to pursue the minor in Finance).
- Have a GPA of 2.50 or above.

- Have completed MATH 1225 Calculus of a Single Variable - MATH 1226 Calculus of a Single Variable or MATH 1524 Business Calculus with grade(s) of C- or better.

Students can apply for the Finance minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Graduation Requirements

The minor in Finance requires 27 credit hours of course work as described above. The footnotes indicate some substitutions that might reasonably be expected. In order to graduate, students must have a 2.00 GPA in all courses used to fulfill the minor.

To remain in the minor in Finance program, students must maintain a GPA of at least 2.00 in the courses listed below. A grade of C or better in FIN 3134, FIN 3144, and FIN 3154 is required to receive a minor in Finance. Students who receive a grade of C- in FIN 3134 may enroll concurrently in FIN 3144 and FIN 3154 while re-taking FIN 3134. Students who receive a grade of C- in FIN 3144 and FIN 3154 may enroll concurrently in FIN 42XX courses while retaking FIN 3144 and FIN 3154. A grade of C or better in FIN 3134 is required before enrolling in FIN 42XX courses.

Prerequisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Food Science and Technology (FST) Minor

Code	Title	Credits
Required Minor Courses		
FST/BIOL 3604	Food Microbiology	4
FST 4304	Food Processing	3
or BSE 4604	Food Process Engineering	
FST 4314	Food Processing Laboratory	1
FST 4504	Food Chemistry	3
FST 4524	Food Safety and Quality Assurance	3
Subtotal		14
Restricted Electives		
Select four credit hours of the following to meet 18 credit hour minimum:		4
FST 2014	Introduction to Food Science	
FST/IS/PSCI 2044	Food, War and Conflict	
FST/HNFE 2544	Functional Foods for Health	
FST 3024	Principles of Sensory Evaluation	
FST/HORT 3114	Wines and Vines	
FST 3124	Brewing Science and Technology	
FST/APSC 3214	Principles of Meat Science	
FST 3514	Food Analysis	
FST 4104	Applied Brewing Science and Engineering	
FST 4634	Epidemiology Foodborne Disease	
Subtotal		4
Total Credits		**18**

Graduation Requirements

Total credits required is 18.
A minimum GPA of 2.0 is required in all courses taken to fulfill this minor.

Forestry (FORS) Minor

Code	Title	Credits
Complete a minimum of 21 credits from the courses listed below.		
Required Minor Courses (Complete all courses below - 9 credits)		**9**
FREC 2214	Introduction to Land and Field Measurements *	
FREC 2314	Forest Biology and Dendrology	
FREC 2324	Dendrology Laboratory	
FREC 3364	Environmental Silviculture *	
Subtotal		9
Restricted Electives		
Select a minimum of 12 additional credits of the following: Note: 3 credit hours must be at the 3000 level or above.		12
FREC 2004	Forest Ecosystems	
FREC 2114	Ecology of Appalachian Forests	
FREC 2124	Forests, Society & Climate	
FREC 2414	Field Experience in Forest Resources and Environmental Conservation	
FREC 2514	Wildland Fire: Ecology and Management *	
FREC/WATR 3104	Principles of Watershed Hydrology *	
FREC 3214	Forest Biometrics *	
FREC 3224	Forest Measurements Field Laboratory *	
FREC 3314	Forest Ecology and Silvics *	
FREC 3714	Forest Harvesting *	
FREC 3724	Forest Boundaries and Roads *	
FREC 3734	Forest Fiber Supply *	
FREC/NR 4014	Natural Resources Economics *	
FREC 4024	Forest Resources Management and Business	
FREC 4114	Information Technologies for Natural Resource Management *	
FREC 4134	Forest Carbon Management and Policy	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
FREC/CSES 4334	Principles and Practice of Agroforestry	
FREC 4354	Forest Soil and Watershed Management *	
FREC 4374	Forested Wetlands *	
FREC 4414	Advanced Wildland Fire Management *	
FREC 4454	Urban and Community Forestry	
FREC 4514	Forest and Tree Pest Management *	
Subtotal		12
Total Credits		**21**

* Course has prerequisites or restrictions. Check course catalog or timetable for further information.

Graduation Requirements

NOTES FOR THE MINOR IN FORESTRY

1. A minimum G.P.A. of 2.0 in these courses is required to complete the minor.
2. All courses must be taken for A–F grade unless only offered P/F.

STEPS FOR COMPLETING THE MINOR IN FORESTRY

1. Complete the form to declare a minor in the College of Natural Resources and Environment Advising Center.
2. If you have questions about the checksheet, ask the Advising Center to put you in contact with the departmental advisor or a faculty member in forestry.
3. When you request or update your DARS, be sure to include the minor so that it will check your progress on both your major and minor.
4. Once you have enrolled in the minor, you cannot graduate until you either (i) satisfy the credit requirements for the minor, or (ii) withdraw from the minor by notifying the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall) and revising your DARS.

French (FR) Minor

Code	Title	Credits
Required Minor Courses		
FR 2105	Intermediate French [1,2]	3
FR 2106	Intermediate French [1,2,3]	3
FR 3105	Composition, Conversation and Grammar [4]	3
FR 3106	Composition, Conversation and Grammar [4]	3
FR 3304	Introduction to French Literature	3
Select one of the following:		3
FR 3314	Introduction to Francophone Studies [4]	
FR 3424	French Culture from Middle Ages to Renaissance	
FR 3434	French Culture from Baroque to Revolution [4]	
FR 3444	French Culture from Romanticism to Belle Epoque [4]	
FR 3454	French Culture from World Wars to Global Present [4]	
Total Credits		**18**

1. Any 3000- level or 4000- level French course may be substituted for FR 2105 or FR 2106.
2. FR 2114 Accelerated Intermediate French (6 s.h.) may be taken in place of FR 2105 and FR 2106.
3. FR 2164 Intermediate Business French (3 s.h.) may be taken in place of FR 2106.
4. May also count toward Pathways.

Graduation Requirements

Requirements: 18 semester hours of coursework at the 2000 or 3000 level

Please note:

- Students must earn 18 credit hours for the French minor regardless of initial course placement[1].
- If you have AP or IB French credit, see your French Advisor of instructor. AP exam credit and IB diploma credit are usually awarded automatically by the Office of the University Registrar. Depending on your score, those credits may possibly be used to satisfy certain requirements for the minor. Make sure you inquire about these substitutions early on.
- Students must have a 2.0 in-minor GPA in French.
- All courses required to complete the French minor are included in the minor GPA calculation. Students must earn a C or better in each course for it to count towards the minor
- French courses may also be used to meet certain Pathways requirements. Please see the current Pathways for General Education Guide.

French for Business (FRBS) Minor

Requirements: 18 semester hours of coursework, distributed as follows:

Code	Title	Credits
Required Minor Courses		
FR 3105	Composition, Conversation and Grammar	3
FR 3106	Composition, Conversation and Grammar	3
Select two of the following:		6
FR 2164	Intermediate Business French [1]	
FR 3164	Advanced Business French	
FR 4164	Special Topics in Business French	
Select two of the following:		6
FR 2714	Introduction to French Culture and Civilization	
FR 3304	Introduction to French Literature	
FR 3314	Introduction to Francophone Studies	
FR 3424	French Culture from Middle Ages to Renaissance	
FR 3434	French Culture from Baroque to Revolution	
FR 3444	French Culture from Romanticism to Belle Epoque	
FR 3454	French Culture from World Wars to Global Present	
FR 4154	Advanced Composition and Stylistics	
Total Credits		**18**

1. Cannot be taken after FR 3105 or FR 3106.

Graduation Requirements

Requirements: 18 semester hours of coursework

Please note:

- Students must earn 18 credit hours for the French major regardless of initial course placement[1].
- If you have AP or IB French credit, see your French Advisor of instructor. AP exam credit and IB diploma credit are usually awarded automatically by the Office of the University Registrar. Depending on your score, those credits may possibly be used to satisfy certain requirements for the minor. Make sure you inquire about these substitutions early on.
- Students must have a 2.0 in-minor GPA in French.
- All courses required to complete the French minor are included in the minor GPA calculation. Students must earn a C or better in each course for it to count towards the minor

- French courses may also be used to meet certain Pathways requirements. Please see the current Pathways for General Education Guide.

1. Any 3000- level or 4000- level French course may be substituted for FR 2105 or FR 2106.
2. FR 2164 Intermediate Business French (3 s.h.) may be taken in place of FR 2106.
3. May also count toward Pathways.

Gender, Science and Technology (GST) Minor

Code	Title	Credits
Required Minor Courses (to be taken in sequence) (15 credits)		
WGS 1824	Introduction to Womens and Gender Studies	3
STS 1504	Introduction to Science, Technology, and Society	3
HIST/STS/SOC 2604	Introduction to Data in Social Context	3
or STS 3314	Medical Dilemmas and Human Experience	
WGS/STS 4334	Sexual Medicine (Pre: WGS 1824 or WGS 1114)	3
WGS/STS 4704	Gender and Science (Pre: STS 1504)	3
Subtotal		15
Elective Courses		
Select one of the following:		3
WGS 2254	Feminist Activism	
WGS 3004	Topics in Feminism	
STS/APS 3124	Societal Health in North America	
UAP/WGS/ GEOG 4214	Gender, Environment, and International Development	
WGS 4224	Women's Studies Seminar	
WGS 4754	Internship	
WGS 4974	Independent Study	
STS 4304	Contemporary Issues in Science, Technology, and Society	
Subtotal		3
Total Credits		**18**

Please Note: Students cannot take more than 3 credit hours of either Internship or Independent Study. Up to six credits of special offerings, such as Independent Study (4974), or Undergraduate Research (4994) in any department may be used to fulfill requirements for the minor where appropriate.

Permission to include such courses must be granted by the minor coordinator. For additional information contact: Dr. Christine Labuski at chrislab@vt.edu

Graduation Requirements

The Minor in Gender, Science, and Technology (GST) requires the completion of 18 credit hours as outlined. Five specific courses are required. Three additional credits of electives at the 3000 or 4000 level are also required. A minimum GPA of 2.0 in all courses taken to fulfill the minor is required.

Geographic Information Science (GIS) Minor

Code	Title	Credits
Required Minor Courses		
CS 1064	Introduction to Programming in Python	3
GEOG 2084	Principles of Geographic Information Systems	3
GEOG 4084	Modeling with Geographic Information Systems	3
GEOG 4354	Introduction to Remote Sensing	3
or FREC 4214	Forest Photogrammetry and Spatial Data Processing	
Subtotal		12
Geographic Information Science Options		
Select two of the following:		6
FREC 4114	Information Technologies for Natural Resource Management	
GEOG 3314	Cartography	
GEOG 4254	R Programming for Geospatial Applications	
GEOG 4314	Spatial Analysis in Geographic Information Systems	
GEOG 4324	Algorithms in Geographic Information Systems	
GEOG 4334	Geospatial Information Technology for Land Change Modeling	
GEOG 4374	Remote Sensing and Phenology	
GEOG 4394	Introduction to Web Mapping	
GEOG 4404	Geovisualization	
Subtotal		6
Total Credits		**18**

Graduation Requirements

A minimum overall GPA of 2.0 in these courses is required to complete the minor.

All minors must Include 6 or more credits at 3000 level or above.

All courses must be taken for an A-F grade unless they are only offered P/F.

Steps for completing the minor In Geographic Information Science for Non-Majors:

- Declare minor using a 'Major/Option/Minor Form' found In the CNRE Advising Center, 138 Cheatham Hall.
- Include minor Information when updating the application for degree In Hokie Spa.
- Students cannot graduate until they have either:
  a. satisfied the requirements for the minor or
  b. withdrawn from the minor by notifying CNRE Academic Programs office In 138 Cheatham and revised their DARS.

Geographic Information Science (GIS-G) Minor Meteorology/ Geography Majors

Code	Title	Credits
Required Minor Courses		
CS 1064	Introduction to Programming in Python	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG/GEOS 4354	Introduction to Remote Sensing	3
or FREC 4214	Forest Photogrammetry and Spatial Data Processing	
Subtotal		9
Geographic Information Science Options		
Select three of the following:		9
FREC 4114	Information Technologies for Natural Resource Management	
GEOG 4254	R Programming for Geospatial Applications	
GEOG 4314	Spatial Analysis in Geographic Information Systems	
GEOG 4324	Algorithms in Geographic Information Systems	
GEOG 4334	Geospatial Information Technology for Land Change Modeling	
GEOG 4374	Remote Sensing and Phenology	
GEOG 4394	Introduction to Web Mapping	
GEOG 4404	Geovisualization	
Subtotal		9
Total Credits		**18**

Graduation Requirements

- A minimum overall GPA of 2.0 In these courses is required to complete the minor.
- All minors must Include 6 or more credits at 3000 level or above.
- All courses must be taken for an A-F grade unless they are only offered P/F.

Steps for completing the minor in Geographic Information Science-G

- Declare minor using a 'Major/Option/Minor Form' found in the CNRE Advising Center, 138 Cheatham Hall.
- Include minor information when updating the application for degree in Hokle Spa.
- Some courses In the minor requirements listed above have prerequisites, so be sure to consult the University Catalog or check with the Minor advisor.
- Students cannot graduate until they have either:
  a. satisfied the requirements for the minor or
  b. withdrawn from the minor by notifying CNRE Academic Programs office In 138 Cheatham and revised their DARS.

Geography (GEOG) Minor

Code	Title	Credits
Required Minor Courses		
GEOG 1004	Introduction to Human Geography	3
GEOG 1014	World Regions	3
GEOG 1104	Introduction to Environmental Geography	3
GEOG 2314	Maps and Mapping	3
or GEOG 3314	Cartography	
Subtotal		12
Geography Electives		
Select nine credits		9
Subtotal		9
Total Credits		**21**

Graduation Requirements

- Upon declaring the Geography minor, students majoring in Meteorology must complete at least 6 credits of elective GEOG courses not counted toward their MTRG major requirements.
- A minimum overall GPA of 2.0 in these courses is required to complete the minor. All minors must include 6 or more credits at 3000 level or above.
- All courses must be taken for an A-F grade unless they are only offered P/F.

Steps for completing the Geography Minor

- Declare minor using a 'Minor Declaration Form' found on the CNRE Advising Center website: www.cnre.vt.edu/advising
- Include minor information when updating the application for degree in Hokie Spa.
- Students cannot graduate until they have either:
  a. satisfied the requirements for the minor OR
  b. withdrawn from the minor by notifying CNRE Academic Programs office in 138 Cheatham and revised their OARS.

Geosciences (GEOS) Minor

Code	Title	Credits
Section 1. GEOS Foundation		
Select one of the following options:		6-7
Option 1:		
GEOS 1004 & GEOS 1104	Earth Science: Our Past, Present, and Future and Introduction to Earth Sciences Laboratory	
or GEOS 210	Elements of Geology	
GEOS 1014	Evolution of the Earth-Life System	
Option 2:		
GEOS 2024	Earth's Dynamic Systems	
Subtotal		6-7
Section 2. GEOS Electives		
GEOS 3000 or 4000 Electives		12
Total Credits		**18-19**

Graduation Requirements

In order to minor in Geosciences, a student must have a minimum in-minor GPA of 2.0.

A minimum of 18 hours is required to graduate with a Geosciences minor.

German (GER) Minor

Code	Title	Credits
Required Minor Courses		
GER 3105	Grammar, Composition and Conversation	3
GER 3106	Grammar, Composition and Conversation	3
Select two of the following:		6
GER 3204	Culture of the German-Speaking Countries	
GER 3305	Topics in German Culture and Literature	
GER 3306	Topics in German Culture and Literature	
GER elective approved by a German advisor [1]		
Subtotal		12
Elective Courses		
Select two GER electives		6
Subtotal		6
Total Credits		**18**

[1] Minor credit for the following advanced-level courses taught in English may be awarded with the approval of the instructor and the German advisor: GER 3474 and GER 4334. A maximum of one such course may be counted for minor credit.

Graduation Requirements

18 hours of coursework at the 2000-level – 2015 and 2016 OR 2114, as necessary – and above

- A minimum grade of "C" must be earned in each course completed for the German minor and an average GPA of 2.0 in all courses taken for the German Minor is required for completion.
- Courses used to fulfill major, minor, or Pathways General Education requirements may not be taken Pass/Fail.
- German courses may also be used to meet Pathways Concepts 2 and Pathways Concepts 6 requirements. See the current Pathways Course Catalog.
- AP placement exam credit or IB diploma credit may be used to satisfy certain requirements for the minor. Students should consult their assigned minor advisor.
- Students may transfer all German credit earned abroad, but at least 25% of the German minor (a minimum of 2 courses) must be taken at Virginia Tech.
- When choosing among 3204, 3305, 3306, students must take two courses with different course numbers.

Courses that do not count toward the minor:

GER 2724 Introduction to German Culture and Civilization

GER 2964 Field Study

GER 4964 Field Study

Global Business Practices to Improve the Human Condition (GBP) Minor

Code	Title	Credits
I. Required Core Courses		
a. Foundational Courses		
HTM/MGT 2314	Introduction to International Business	3
ECON 2005	Principles of Economics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
b. Analytical Thinking Course		
HIST/SOC/STS 2604	Introduction to Data in Social Context (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 5 - Quantitative and Computational Thinking 5F)	3
c. Prosperity and Social Change Course		
Select one of the following:		3
SOC 2004	Social Problems (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
SOC 2024	Sociology of Race and Ethnicity (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
Subtotal		12
II. Track Courses		
Select 6 credits of the following (follow either the Social Change Track or the Prosperity Track):		6
Social Change Track		
Select two of the following:		
HUM/RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences)	
IS 4014	International Development	
MGT 2204	Global Business of Pop Culture (Pathways Concept 2 - Critical Thinking in the Humanities and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
MGT 3444	Multicultural Diversity in Organizations (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
MGT 4314	International Management (Junior Standing; fall only)	
MGT 4334	Ethical Leadership and Corporate Social Responsibility (Pathways Concept 1 - Discourse 1A and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
MKTG 4644	Marketing, Society and the Public Interest	
SOC 2034	Diversity and Community Engagement (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
SOC 3854	Globalization: Sociological Perspectives	
SPIA 1024	Community Service Learning (Pathways Concept 3 - Reasoning in the Social Sciences)	
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	
SPIA 4464	Data and the Art of Policy-Making and Planning (Pathways Concept 5 - Quantitative and Computational Thinking 5A)	
Prosperity Track		
Select two of the following:		

AAEC 3204	International Agricultural Development and Trade (Pathways Concept 3 - Reasoning in the Social Sciences)	
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
ECON 3004	Contemporary Economic Issues	
ECON/PPE 3024	Economic Justice	
ECON 4124	Growth and Development	
FIN 4144	International Financial Management	
GEOG/SPIA 2244	Sustainable Urbanization (Pathways Concept 3 - Reasoning in the Social Sciences , $30 fee)	
HTM 3484	Socio-Cultural Impacts of Tourism (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
MGT 3074	Social Entrepreneurship	
PSCI/GEOG/IS 2064	The Global Economy and World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	
PSCI/IS 4054	Seminar in Global Political Economy (Senior Standing)	
Subtotal		6
III. Capstone Experience		
Select one of the following:		3
XXXX 3954 Study Abroad - must have approval from Pamplin International Programs *		
XXXX 4974 Independent Study - must have approval from Pamplin International Programs *		
XXXX 4994 Undergraduate Research - must have approval from Pamplin International Programs *		
Subtotal		3
Total Credits		**21**

* Must contain an experiential social change or prosperity component. Guidelines for content coverage will be provided and must be followed for course to count toward minor.

Graduation Requirements

Application Eligibility

The Global Business Practices to Improve the Human Condition (GBP) minor is open to all university students with a GPA of at least 2.0.

Students can apply for the GBP minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Graduation Requirements

To complete the Global Business Practices to Improve the Human Condition minor, students must pass the 21 credits of required and elective classes with an average GPA of a 2.5 in these courses. Students must complete at least 6 out of the 21 credits at the 3000-4000 level. No course grade may be lower than C- to earn the minor. Additionally, students must complete an experience with a social or economic change component approved by Pamplin International Programs. If these criteria are met, the minor will be noted on the student's transcript.

Pre-Requisite Statement

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or consult with your academic advisor.

Requirements

No more than two courses may be double counted toward graduation major requirements. A course cannot be used more than once to meet section requirements for this minor.

Global Engagement (GLBE) Minor

Program Curriculum

Code	Title	Credits
Required Minor Courses		
Select one of the following:		3
IS 1024	Comp Gov & Politics	
IS/PSCI/GEOG 2054	Introduction to World Politics	
IS/PSCI/GEOG 2064	The Global Economy and World Politics	
Subtotal		3
Elective Courses		
Select 15 hours from the following:		15
IS 3954	Study Abroad	
IS/PSCI 4034	Topics in Diplomacy Lab	
IS/PSCI 4735	Topics in Multilateral Diplomacy Workshop	
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop	
IS/PSCI 4744	Intelligence Analysis Workshop	
IS 4754	Internship	
IS 4964	Field Study	
IS 4994	Undergraduate Research	
Subtotal		15
Total Credits		**18**

Graduation Requirements

Hours Requirement: A minimum of 18 hours is required to graduate with an Global Engagement minor.

GPA requirement: GPA of 2.0 is required for the Global Engagement minor. All courses listed on this checksheet are included in the Global Engagement minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Dual Use of Courses: No course can double count within or between International Studies-related majors or minors with the exception of the Core Degree Requirements and IS 1004 Nations and Nationalities, IS 2054 Introduction to World Politics and IS 2064 The Global Economy and World Politics.

Intra-IS Program majoring and minoring: Students may pursue more than one major or minor associated with the International Studies Program. In this case, the policy pertaining to the "Dual Use of Courses" will apply.

Intra-departmental majoring and minoring: Students pursuing one or more majors associated with the International Studies Program cannot major or minor in Political Science.

Global Food Security and Health (GFSH) Minor

Code	Title	Credits
Required Minor Courses		
Introductory Pathways Courses		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
CSES 2244	Agriculture, Global Food Security and Health	3
Middle Pathways Course		
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience	3
Other Non-Pathways Required Courses		
ALS 2964 FIELD S		1
or ALS 3954	Study Abroad	
or ALS4994		
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	3
Subtotal		13
Restricted Electives		
Select two of the following (minimum 6 credits):		6
AAEC 3024	Monetary and Global Issues in Applied Economics	
AAEC 3204	International Agricultural Development and Trade	
AAEC 3324	Environment and Sustainable Development Economics	
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations	
ALS 2964	Field Study	
or ALS 3954	Study Abroad	
or ALS 4994	Undergraduate Research	
FREC 2124	Forests, Society & Climate	
FREC 2784	Global Forest Sustainability	
FREC 4014	Natural Resources Economics	
FST/IS/PSCI 2044	Food, War and Conflict	
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences)	
GEOG 4214	Gender, Environment, and International Development	
HORT 2184	Plants, Places, and Cultures in a Global Context	
PHS 2004	Introduction to Public Health	
PPWS 2104	Plants, Genes, and People	
SPES 2244	World Crops: Food and Culture	
Subtotal		6
Total Credits		**19**

Graduation Requirements

Notes

- The Global Food Security and Health minor is an interdisciplinary program that explores the biophysical, technological, and institutional drivers that contribute to global food security and population health.
- Minimum credits to complete minor =19
- Minimum GPA of 2.0 in all courses taken to fulfill the minor is required
- A minimum of 6 credits at the 3XXX-4XXX level must be completed
- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor.
- Students choosing Global Food Security and Health minor will register with the Office of Academic Programs in the College of Agriculture and Life Sciences, 1060 Litton Reaves Hall. This will enable the college to provide any pertinent assistance, materials, and information to the student.
- Faculty advisor in the Office of Academic Programs will serve as a counterpart to the student's major advisor.
- If you have any questions, please contact Dr. Ozzie Abaye at cotton@vt.edu or Karen Drake-Whitney at kdrake@vt.edu

Green Engineering (GREN) Minor

Code	Title	Credits
Required Minor Courses		
ENGR 3124	Introduction to Green Engineering	3
Select one of the following:		3
ENGR 4134	Environmental Life Cycle Assessment [1]	
CEE 4134	Environmental Sustainability - A Systems Approach [1,2]	
ME/ESM 4194	Sustainable Energy Solutions for a Global Society [1]	
Subtotal		6
Elective Courses		
Engineering Electives		
Select 6 hours of the following:		6
AOE 4064	Fluid Flows in Nature [2]	
AOE 4634	Wind Turbine Technology and Aerodynamics [2]	
BC 3014	Building Physics and Environmental Systems	
BC 4314	Building Performance and Energy Management	
BC 4334	Sustainable Building Performance Management	
BSE 3324	Small Watershed Hydrology [2]	
BSE 3334	Nonpoint Source Pollution Assessment and Control [2]	
BSE 3534	Bioprocess Engineering [2]	
BSE 4304	Introduction to Watershed Modeling [2]	
BSE 4394	Water Supply and Sanitation in Developing Countries (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States) [7]	
BSE 4524	Biological Process Plant Design [2]	
CHE 3134	Separation Processes [2]	
CHE 3144	Mass Transfer	
CHE 4114	Energy and Climate Change Solutions	
CEE 3104	Introduction to Environmental Engineering (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States) [2]	

CEE 4104	Water and Wastewater Treatment Design [2]
CEE 4114	Fundamentals of Public Health Engineering [2]
CEE 4134	Environmental Sustainability - A Systems Approach [1,2]
CEE 4144	Air Resources Engineering [2]
CEE 4174	Solid and Hazardous Waste Management [2]
CEE 4264	Sustainable Land Development [2]
CEE 4304	Hydrology [2]
CEE 4314	Groundwater Resources [2]
CEE 4334	Hydraulic Structures [2]
CEE 4344	Water Resources Planning [2]
CEE 4384	Coastal Engineering [2]
CEE 4394	Urban Water Sustainability [2]
CEE 4554	Natural Disaster Mitigation and Recovery [2]
ECE 4324	Microgrids
ECE 4364	Alternate Energy for Climate Sustainability [2]
ENGR 4134	Environmental Life Cycle Assessment [1]
ISE 3204	Manufacturing Processes
ISE 4304	Global Issues in Industrial Management [2]
ISE 4644	Risk and Hazard Control [2]
ISE 4654	Principles of Industrial Hygiene [2]
MSE 2044	Fundamentals of Materials Engineering [2]
MSE 4055	Materials Selection and Design I and II [2]
ME 4034	Bio-Inspired Technology [2]
ME 4164	Energy Systems for Buildings [2]
ME/ESM 4194	Sustainable Energy Solutions for a Global Society [1]
ME 4204	Internal Combustion Engines [2]
ME 4554	Advanced Technology for Motor Vehicles [2]
ME 4724	Engineering Acoustics [2]
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development
MINE 2544	Leadership for Responsible Mining [2]
MINE 3644	Applications in Mineral Processing [2]
MINE 4624	Mine and Water Reservoir Engineering
MINE 4644	Environmental Management for Mining and Geoenergy [2]
NSEG 3145	Fundamentals of Nuclear Engr [2]
NSEG 3146	Fundamental of Nuclear Engr [2]
NSEG 3604	Radiation Detection, Protection and Shielding [2]
NSEG 4204	Nuclear Fuel Cycle [1]

Interdisciplinary Electives

Select 6 hours of the following:		6
AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
AAEC 4314	Environmental Economic Analysis and Management	
AAEC 4344	Sustainable Development Economics	
APSC/DASC 3134	Animal Agriculture and the Environment	
ARCH 4055	Environment and Building Systems [2]	
ARCH 4056	Environment and Building Systems [2]	
BIOL 2604	General Microbiology	
BIOL 2804	Ecology [2]	
BIOL 4004	Freshwater Ecology [2]	
BIOL 4014	Environmental Toxicology [2]	
BIOL 4114	Global Change Ecology [2]	
BIOL 4314	Plant Ecology [2]	
BIOL 4334	Chemical Ecology [2]	
CHEM 4514	Green Chemistry	
CHEM 4624	Materials Chemistry in Energy Sciences	
CSES 4644	Land-based Systems for Waste Treatment	
CSES 4854	Wetland Soils and Mitigation	
ECON 4014	Environmental Economics [2]	
ENGL 3534	Literature and the Environment (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) or Pathways Concept 2 - Critical Thinking in the Humanities)	
ENSC 3134	Soils in the Landscape	
ENSC 3604	Fundamentals of Environmental Science (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
ENSC 3634	Physics of Pollution	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC/BIOL 4164	Environmental Microbiology	
ENSC 4314	Water Quality	
ENSC/CHEM 4734	Environmental Soil Chemistry	
ENSC 4764	Bioremediation	
ENSC 4774	Reclamation of Drastically Disturbed Lands	
ENT 2004	Insects and Human Society (Pathways Concept 4 - Reasoning in the Natural Sciences)	
ENT/PPWS 4264	Pesticide Usage	
ENT/BIOL 4354	Aquatic Entomology [2]	
ENT/BIOL/FIW 4484	Freshwater Biomonitoring [2]	
FIW 2114	Principles of Fish and Wildlife Conservation (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FIW 2234	Fish, Fishing, and Conservation (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 4 - Reasoning in the Natural Sciences)	
FIW 4614	Fish Ecology	
FREC 2004	Forest Ecosystems (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC 2114	Ecology of Appalachian Forests (Pathways Concept 4 - Reasoning in the Natural Sciences)	
FREC 2124	Forests, Society & Climate (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 4 - Reasoning in the Natural Sciences)	

FREC/LAR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)
FREC/WATR 3104	Principles of Watershed Hydrology
FREC 3604	
FREC 3754	Watersheds and Water Quality Monitoring
FREC/CSES 4334	Principles and Practice of Agroforestry
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences)
GEOG 4204	Geography of Resources
GEOS 2104	Elements of Geology
GEOS 3014	Environmental Geosciences
GEOS 3034	Oceanography
GEOS 4634	Environmental Geochemistry
GEOS 4804	Groundwater Hydrology
HIST 3144	American Environmental History (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)
HORT/FREC 2134	Plants and Greenspaces in Urban Communities (Pathways Concept 4 - Reasoning in the Natural Sciences)
LAR 3154	Watershed Sensitive Site Design and Construction
LAR 4034	Evolution of the American Landscape (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) or Pathways Concept 2 - Critical Thinking in the Humanities)
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives
PSYC 3024	Human Behaviors and Natural Environments (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)
RED 4604	Environmental and Sustainability Issues in Housing (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)
SBIO 2124	Structure and Properties of Sustainable Biomaterials
SBIO 2504	Circular Economy Analytics for Sustainable Systems (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))
SBIO/FREC 2784	Global Forest Sustainability
SBIO 3004	Sustainable Nature-Based Enterprises
SBIO 3324	Green Building Systems
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials
SBIO 3444	Sustainable Biomaterials and Bioenergy
SBIO 3454	Society, Sustainability Biomaterials and Energy
SBIO 3554	Sustainable Biomaterials Enterprises
SBIO 4444	Plant Polymers & Biocomposites
SOC 3404	Environmental Justice
SPIA 4454	Future of Cities (Pathways Concept 3 - Reasoning in the Social Sciences or Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) ; Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))
SPIA 4554	Creating the Ecological City
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities)
STS 3334	Energy and Society (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences) [4,6]
UAP 3354	Introduction to Environmental Policy and Planning
UAP 4374	Land Use and Environment: Planning and Policy
UAP 4394	Community Renewable Energy Systems
UAP 4854	Planning of the Urban Infrastructure
Subtotal	12
Total Credits	**18**

[1] These courses count either as a required course or an engineering elective, but not both

[2] Prerequisites and non-major enrollment restrictions apply.

Graduation Requirements

To complete a minor in Green Engineering, students must:

1. Complete a total of 18 credits
   a. 6 credits of required courses
   b. 6 credits of engineering electives from list
   c. 6 credits of interdisciplinary electives from list
2. Complete all courses as an A-F grade mode
3. Earn a minimum 2.0 GPA for the 18 credits that fulfill the minor

Additional Comments

1. Review the course prerequisites when deciding on the electives.
2. Not all courses are offered each term.
3. 1000 level courses will not be considered for substitutions.
4. Senior Capstone Design projects and Undergraduate Research in engineering departments are eligible as engineering electives if the project focuses on environmental impacts. See program advisor for **advance** approval of projects.
5. Other courses, including Study Abroad, may be substituted on a case-by-case basis with approval from the Green Engineering Director and College of Engineering Associate Dean of Academic Affairs (e.g., NR/GEOG 3954 Study Abroad may be substituted if the Stud Abroad trip is concerned directly with environment and sustainability.)
6. Dr. Sean McGinnis, Director of Green Engineering (287 Holden Hall), will act as an advisor for all student pursuing a Green Engineering minor. Email: smcginn@vt.edu, Website: www.eng.vt.edu/green (https://catalog.vt.edu/undergraduate/minors/green-engineering-minor/www.eng.vt.edu/green/)

Health Communication (HCOM) Minor

Code	Title	Credits
Required Minor Courses [1]		
Foundational Courses		
Select one of the following:		
COMM 1016	Communication Skills (Pathways Concept 1 - Discourse (1F) ; Integrated Outcome: Pathways Outcome 10 - Ethical Reasoning)	3
or		
COMM 2004	Public Speaking (Pathways Concept 1 - Discourse (1A) ; Integrated Outcome: Pathways Outcome 10 - Ethical Reasoning)	
ADV 2134	Introduction to Health Communication (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Pathways Outcome 10 - Ethical Reasoning)	3
PHS 2004	Introduction to Public Health	3
HIST/SOC/STS 2604	Introduction to Data in Social Context (Pathways Concept 5 - Quantitative and Computational Thinking (5F) ; and Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Pathways Outcome 11 - Intercultural and Global Awareness) [1]	3
Subtotal		12
Elective Courses		
Select one course from each of the following groups: [2]		6
Group A		
CMST 3124	Interpersonal Communication	
COMM 2084	Media and Society (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Pathways Outcome 11 - Intercultural and Global Awareness) [1]	
GEOG 2014	Health and Place: Introduction to Health Geography (Pathways Concept 1 - Discourse (1A) ; Integrated Outcome: Pathways Outcome 11 - Intercultural and Global Awareness)	
HD 2004	Adulthood and Aging (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Pathways Outcome 11 - Intercultural and Global Awareness)	
HD 2304	Family Relationships	
PSYC 3054	Health Psychology	
Group B		
CMST 3064	Persuasion	
HD 3024	Community Analytics (Pathways Concept 5 - Quantitative and Computational Thinking (5A) ; Integrative Outcome: Pathways Outcome 10 - Ethical Reasoning)	
PHS 4014	Public Health Program Planning and Evaluation	
PR 2044	Principles of Public Relations (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Pathways Outcome 10 - Ethical Reasoning) [1]	
SOC 2034	Diversity and Community Engagement (Pathways Concept 3 - Reasoning in the Social Sciences , and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Pathways Outcome 11 - Intercultural and Global Awareness) [1]	
Health Communication Capstone [3]		
ADV 4324	Issues in Health Communication	3
Total Credits		**21**

1. Prerequisites: Some courses listed for this minor may have pre/co-requisites; please consult the University Course Catalog or check with your advisor.
2. No more than 50% of the graded course credits required for Minor in Health Communication (HCOM) may be double-counted in a student's major.
3. GPA Requirement: A GPA of 2.0 or higher is required in the minor. The GPA is based on all courses a student has completed for the Minor in Health Communication (HCOM).

Graduation Requirements

- Minimum credits to complete the minor: 21
- GPA Requirement: A GPA of2.0 or higher is required in the minor. The GPA is based on all courses a student has completed in the health communication minor.
- Minimum of 6 credits must be completed at the 3XXX and/or 4XXX level
- If completing this minor to satisfy Pathways General Education requirements, please reference the core and/or integrated outcome(s) satisfied by the course during the selection of courses for the completion of this minor.

History (HIST) Minor

Code	Title	Credits
Required Minor Courses		
Select a minimum of 18 semester hours of history courses [1]		18
At least 12 hours at the 2000 level or above		
At least 6 hours at the 3000 level or above		
Subtotal		18
Total Credits		**18**

History Depth Studies Course Groupings (HIST)

HIST Group I (Empires, Colonialism, and Globalization)

Code	Title	Credits
AINS 3684	Indigenous Peoples and World Politics	3
HIST 1224	Mesoamerica and the Andes	3
HIST 2165		3
HIST 2166	History of France	3
HIST 2346	History of the Middle East	3
HIST 2364	History of Japan	3
HIST/RLCL 2384	Gandhi in the Making of Modern India	3
HIST 2394	Tofu to Tikka: Food in Asian History	3
HIST 2484	Modern Germany	3

HIST 3004	Colonial America	3
HIST 3014	The American Revolution	3
HIST/AINS 3174	Native American History	3
HIST 3274	The Greek City	3
HIST 3314	The Later Roman Empire	3
HIST 3234	The North American West	3
HIST 3294	Roman Britain	3
HIST 3364	The Age of Revolution and Napoleon	3
HIST 3374	French Empire	3
HIST 3554	Age of Globalization	3
HIST 3594	The Rise of Modern Latin America	3
HIST 3604	Russia to Peter the Great	3
HIST 3614	Imperial Russia	3
HIST/AFST/IS 3864		3

HIST Group II (Ideas, Traditions, and Cultures)

Code	Title	Credits
HIST 2134	The Revolution Will Be Televised: Topics in History on TV	3
HIST/CLA 2224	Ancient Greek and Roman Women	3
HIST/CLA 2234	Classics in the Modern World	3
HIST/CLA 2244	Cities of Rome	3
HIST 2264	America in the 1960s	3
HIST 2355	History of China	3
HIST 2356	History of Modern China	3
HIST/RLCL 2374	Gods and Kings in Premodern India	3
HIST/AFST 2275	African-American History	3
HIST/AFST 2276	African-American History	3
HIST 2494	Cities in History	3
HIST/CRIM 2504	Crime and Punishment in American History	3
HIST 2514	U.S. Food History	3
HIST 2544	U.S. South: Pre-Colombian to 1865	3
HIST 2554	U.S. South: 1865 to Present	3
HIST 3084	Recent America, 1917-Present	3
HIST 3105	Women in U S History	3
HIST 3106	Women in U S History	3
HIST/CRIM 3124	Murder in American History	3
HIST 3134	Sports in American History	3
HIST 3164	Sexuality in American History	3
HIST/APS 3214	History of Appalachia	3
HIST 3224	History of Virginia	3
HIST 3324	The Medieval World	3
HIST 3334	The Renaissance World, 1350-1500	3
HIST 3344	Early Modern and Reformation History, 1500-1650	3
HIST/RLCL 3504	The Age of The Crusades	3
HIST 3694	History through Film	3
HIST 3744	Social History of Film	3

HIST Group III (Science, Technology, Environment, and Medicine)

Code	Title	Credits
HIST/STS 2054	Engineering Cultures	3
HIST 2524	History of Agriculture	3
HIST/SOC/STS 2604	Introduction to Data in Social Context	3
HIST 2624	Topics in the History of Data in Social Context	3
HIST/STS 2715	History of Technology	3
HIST/STS 2716	History of Technology	3
HIST 3114		3
HIST 3144	American Environmental History	3
HIST 3484	Nazi Germany: History and Memory	3
HIST 3624	Health and Illness in African History	3
HIST/STS 3705	History of Science	3
HIST/STS 3706	History of Science	3
HIST 3714	War and Medicine	3
HIST 3724	History of Disease, Medicine, and Health	3
HIST/STS 3734	History of Modern Biology	3

HIST Group IV (Conflict, War and Peace)

Code	Title	Credits
HIST 1354	Conflict and Security in Modern East Asia	3
HIST 2184	History of the Balkans	3
HIST 2345	History of the Middle East	3
HIST 2534	America at War	3
HIST 3054	The American Civil War	3
HIST 3254	The Vietnam War	3
HIST 3284	The Roman Revolution	3
HIST 3304	The World of Alexander the Great	3
HIST/JUD/RLCL 3494	The Holocaust	3
HIST 3534	Modern Military History	3
HIST 3544	World War II	3
HIST 3564	The Cold War	3
HIST 3644	Twentieth-Century Russia	3
HIST 3654	Arab-Israeli Conflict	3
HIST 3664	Revolutionary China	3

Graduation Requirements

To earn a minor in history, a student must satisfactorily complete a minimum of 18 semester hours of history courses with a minimum 2.0 GPA in all courses taken to satisfy the minor. **The 18 hours for the minor must include at least 3 hours of credit from each of three of the four groups of HIST courses (Groups I-IV).**

1. Empires, Colonialism, and Globalization;
2. Ideas, Traditions, and Cultures;
3. Science, Technology, Environment, Medicine;
4. Conflict, War, and Peace.

HIST 1014, HIST 2984, HIST 3984, HIST 2104, HIST 2114, HIST 2124, HIST 3914, and HIST 4914 can be substituted to appropriate groups. Please see course schedule or advisor for more information.

Horticulture (HORT) Minor

Code	Title	Credits
Required Minor Courses		
Complete the following 8 Credits		8
HORT 2224	Horticulture Science and Industry	
HORT 2234	Environmental Factors in Horticulture	
HORT 2244	Plant Propagation	
Subtotal		8
Restricted Electives		
Choose a minimum of 10 credits from the following list: [1]		10
CSES 2224	Foundations of Precision Agriculture	
CSES 4064	Soil Microbiology	
FREC 2254	Arboriculture Field Skills	
HORT 2134	Plants and Greenspaces in Urban Communities	
HORT 2144	Indoor Plants	
HORT 2164	Floral Design	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT/BIOL 2304	Plant Biology	
HORT 2834	Sustainable Agriculture Practicum	
HORT/FST 3114	Wines and Vines	
HORT 3324	Herbaceous Landscape Plants	
HORT 3325	Woody Landscape Plants	
HORT 3326	Woody Landscape Plants	
HORT/FREC 3354	Trees in the Built Environment	
HORT 3664	Hardscape Materials and Installation	
HORT 4205	Public Gardens Maintenance and Management	
HORT 4206	Public Gardens Maintenance and Management	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
HORT 4344	Production of Food Crops in Controlled Environment Agriculture	
HORT 4545	Small Scale and Residential Landscape Design	
HORT 4546	Small Scale and Residential Landscape Design	
HORT 4614	Ornamental Plant Production and Marketing	
HORT 4654	Viticulture	
HORT 4764	Vegetable Crops	
HORT 4784	Vegetable Seed Production	
HORT 4794	Medicinal Plants and Herbs	
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 2244	World Crops: Food and Culture	
Subtotal		10
Total Credits		**18**

[1] For the Restrictive Electives, at minimum, 6 credits must be at the 3000 or 4000 academic level.

Graduation Requirements

- Minimum credits to complete minor = 18
- For Restricted Electives, at minimum 6 of 10 credit hours must be at 3XXX or 4XXX academic level
- Minimum GPA requirement of 2.0 for courses taken towards the minor
- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor.

Housing and Society (HOSO) Minor

Code	Title	Credits
I. Introduction/Foundational Experience Required Minor Courses		
RED 2644	Housing and the Consumer	3
PM 3634	Managing Affordable and Specialized Housing	3
RED 4664	Universal Design (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrative Outcome: Intercultural and Global Awareness) [1]	3
Subtotal		9
II. Mid-Level Experience Elective Courses		
Select six credits from one of the following tracks:		6
Data Analysis Track		
REAL 2034	Real Estate Data Analysis (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Outcome: Ethical Reasoning) [1]	
PM 4644	Advanced Property and Asset Management	
STAT 1014	Data in Our Lives (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Outcome: Ethical Reasoning) [1]	
CONS 2304	Consumer and Family Finances (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Outcome: Ethical Reasoning) [1]	
HIST/SOC/ STS 2604	Introduction to Data in Social Context (Pathways Concept 2 - Critical Thinking in the Humanities & Pathways Concept 5 - Quantitative and Computational Thinking (foundational) ; Integrative Outcomes: Ethical Reasoning and Intercultural and Global Awareness) [1]	
HD/SOC 2104	Quantitative Approaches to Community Research (Pathways Concept 5 - Quantitative and Computational Thinking (advanced); Integrative Outcome: Ethical Reasoning) [1]	
Economics Track		
ECON 1104	Economics of Gender (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]	

ECON 1204	Economics of Race (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]
ECON 1214	Economic History of Diversity and Inclusion (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]
PPE 2894	PPE Gateway Course
ECON 3034	Economics of Poverty and Discrimination (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
Family and Community Track	
Must choose at least one Pathways course	
CONS 2304	Consumer and Family Finances (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Outcome: Ethical Reasoning) [1]
HD 2004	Adulthood and Aging (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]
HD 1134	Introduction to Disabilities Studies (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]
HD 2304	Family Relationships
HD 3024	Community Analytics
HD 2104	Quantitative Approaches to Community Research (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Outcome: Ethical Reasoning) [1]
HD 3234	Child/Youth Community Services
PM 4964	Field Work/Practicum
SOC 2034	Diversity and Community Engagement (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
Social Justice Track	
SOC 2004	Social Problems (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
SOC 3314	Social Movements (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
SOC 3004	Social Inequality [1]
HUM/RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]
PHIL 1304	Morality and Justice (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Ethical Reasoning) [1]
RLCL/AFST/ WGS 2204	Race and Gender in Religion and Culture (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness)
MGT 3444	Multicultural Diversity in Organizations (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
UAP 1024	Leadership, Service, and Public Problem Solving (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Ethical Reasoning)
Sustainability Track	
RED 4604	Environmental and Sustainability Issues in Housing (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
GEOG/SPIA 2244	Sustainable Urbanization (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]
SBIO 3324	Green Building Systems [1]
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Intercultural and Global Awareness) [1]
HORT 2134	Plants and Greenspaces in Urban Communities (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)
FREC/NR/LAR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities & Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcomes: Ethical Reasoning and Intercultural and Global Awareness)
STS 3334	Energy and Society (Pathways Concept 2 - Critical Thinking in the Humanities & Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness)

STS 2254	Innovation in Context (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcomes: Ethical Reasoning and Intercultural and Global Awareness)	
Subtotal		6
III. Capstone Experience Required Course		
PM 4744	Housing Challenges and Policies in the United States (Pathways Concept 3 - Reasoning in the Social Sciences & Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning) [1]	3
Subtotal		3
Total Credits		**18**

[1] Pathways General Education courses: If completing this minor to satisfy Pathways General Education requirements, please reference the core and/or integrated outcome(s) satisfied by the course during the selection of courses for the completion of this minor.

Graduation Requirements

No more than 50% of the graded course credit hours required for the Minor in Housing and Society may be double-counted by a student also enrolled in his/her major.

Some courses listed on the checksheet may have prerequisites, please consult the University Course Catalog, or check with your advisor.

GPA Requirement: A GPA of 2.0 or higher is required in the minor. The GPA is based on all courses a student has completed in the Housing and Society minor.

Human-Computer Interaction (HCI) Minor

Code	Title	Credits
Required Minor Courses		
HIST/SOC/STS 2604	Introduction to Data in Social Context	3
COMM 2084	Media and Society	3
CS 3724	Introduction to Human-Computer Interaction	3
Subtotal		9
Elective Courses		
Select 6 credits of the following (3 from outside CS)		6
Design Focus		
ART 1234	Topics in Visual Communication Design for Non-Majors	
IDS 2214	IDS Studio for Minors	
IDS 2034	Design Visualization	
JMC 4374	New Communications Technology	
Theory and Research Focus		
CMDA/STAT/CS 3654	Introductory Data Analytics and Visualization	
COMM 4024	Communication Law	
ISE 3614	Human Factors Engineering and Ergonomics	
PSYC 1004	Introductory Psychology	
PSYC 2084	Social Psychology	
SOC 3204	Social Research Methods	
Content Focus		
ART 3574	Topics In Graphic Design (Scheduled topics: "Intro Web Design" or "Interaction Design")	
ART 3604	Topics in New Media Art (Scheduled topic: "Multimedia")	
ART 3704	Topics in Computer Animation (Scheduled topic: "Creative Code w/ Processing")	
ART 4504	Topics in Multimedia Studio	
ART 4544	Computer Animation Studio (Scheduled topic: "Adv Creative Code" or "Multimedia/Installation")	
CS 4634	Design Of Information	
MUS 3314	Instrumental Ensemble Music (Linux Laptop Orch)	
Implementation Focus		
CS 3714	Mobile Software Development	
CS 3744	Introduction to GUI Programming and Graphics	
CS 3754	Cloud Software Development	
CS 4624	Multimedia, Hypertext and Information Access	
MUS 3064	Digital Sound Manipulation	
MUS 3065	Computer Music and Multimedia Design	
MUS 3066	Computer Music and Multimedia Design	
MUS 4014	Topics in Advanced Electroacoustic Research	
Subtotal		6
Integrative Capstone		
Select one of the following:		3
CS 4774	Human-Computer Interaction Design Experience (non-CS-majors)	
CS 4784	Human-Computer Interaction Capstone (CS-majors)	
Subtotal		3
Total Credits		**18**

Graduation Requirements

1. HCI minors must earn at least a “C” (2.0) in CS 3724, HIST 2604, and COMM 2084.
2. Students must have an HCI Minor GPA of at least 2.0 to successfully complete the minor.
3. Student must be in a degree-granting major before declaring the minor.
4. Some courses listed on this checksheet have prerequisites. It is the student’s responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to specific majors in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

Humanities, Science and Environment (HSE) Minor

Code	Title	Credits
Required Minor Courses		
Course in Science and Technology in Society		
STS 1504	Introduction to Science, Technology, and Society	3
STS 3104	Science and Technology in Modern Society	3
Subtotal		6
Humanities (Outside STS)		
Select two of the following:		6
ENGL 3534	Literature and the Environment (Pathways Concept 2 - Critical Thinking in the Humanities ; WI) [1]	
FREC 2554	Leadership for Global Sustainability	
HIST 3144	American Environmental History	
HIST 3234	The North American West	
HIST 3734	History of Modern Biology	
RLCL 2464	Religion and Science	
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)	
PHIL 3314	Ethical Theory [1]	
PHIL 4304	Political Philosophy [1]	
PHIL 4604	Philosophy of Biology (WI) [1]	
UAP 4264	Environmental Ethics and Policy [1]	
Subtotal		6
Social Sciences		
Select two of the following:		6
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives (Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States) [1]	
RED 4604	Environmental and Sustainability Issues in Housing	
FIW 4464	Human Dimensions of Fisheries and Wildlife [1]	
FREC 3364	Environmental Silviculture	
FREC 4434	Natural Resource Policy	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 4204	Geography of Resources	
GEOG 4084	Modeling with Geographic Information Systems	
HTM 3484	Socio-Cultural Impacts of Tourism	
MGT 4334	Ethical Leadership and Corporate Social Responsibility [1]	
PSCI/UAP 3714	The U. S. Policy Process (WI) [1]	
SOC 3504	Population Trends and Issues	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4184	Community Involvement	
UAP 4214	Gender, Environment, and International Development [1]	
Subtotal		6
Natural Sciences		
Select two of the following: [2]		6
BIOL 1064	Plants and Civilization [1]	
BIOL 2804	Ecology [1]	
BIOL 4004	Freshwater Ecology [1]	
BIOL 4014	Environmental Toxicology [1]	
BIOL 4314	Plant Ecology [1]	
ENSC 3604	Fundamentals of Environmental Science [1]	
FIW 4614	Fish Ecology [1]	
FIW 4454	Human-Wildlife Conflicts	
FIW 4464	Human Dimensions of Fisheries and Wildlife	
FREC 3524	Environmental Interpretation [1]	
GEOG 4044	Biogeography	
GEOS 3014	Environmental Geosciences	
Subtotal		6
Written, Oral, and Visual Communications		
Select one of the following:		3
COMM 2004	Public Speaking	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
ENGL 4824	Science Writing [1]	
STS 2984	Special Study	
Subtotal		3
Total Credits		**27**

Graduation Requirements

Minimum of 6 credit hours at 3000 level or above is required for the completion of the minor.

Students should discuss requirements for their minor with their advisor prior to registering for classes each semester.

Minimum Grade Point Average

A minimum GPA of 2.0 in all courses taken to fulfill the minor is required.

1 Prerequisites may apply - See your advisor.
2 All Biology 3000 and 4000 level courses have restricted capacity for non-majors.

Industrial Design (IDS) Minor

Code	Title	Credits
Required Minor Courses		
IDS 2214	IDS Studio for Minors	6
IDS 3124	Materials and Processes	3
IDS 2044	Human Factors [1]	3
IDS 2114	History of Industrial Design	3
or IDS 2124	History of Modern Industrial Designers	
Subtotal		15
Elective Courses		
Select 3 credits of the following:		3
ARCH 3504	Topics in Architectural Media and Methods	
IDS 4974	Independent Study	
IDS 3204	Topics in Professional Development	
IDS 3224	Topics in Design Competencies	
IDS 3234	Topics in Design Theory	

Subtotal	3
Total Credits	**18**

[1] ARCH 1015/1016 prerequisite for Human Factors is waived for minor students. See department for force add procedure.

Graduation Requirements

The minor requires 18 hours, with no less than 6 hours at the 3000 or 4000 level.

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Innovation (INNO) Minor

Code	Title	Credits
Required Minor Courses		
STS 2254	Innovation in Context (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrated Concept 10: Ethical Reasoning and 11: Intercultural and Global Awareness)	3
ENGE 2094	Create!: Ideation & Innovation (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrated Concept 11: Intercultural and Global Awareness)	3
MGT/ENGE/IDS 4094	Startup: Commercialization of Innovation (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrated Concept 10: Ethical Reasoning)	3
Subtotal		9
Elective Courses		
Select a minimum of nine credit hours from the following:		9
ACIS 1004	Accounting Foundations (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Concept: 10)	
AHRM 1014	Design and Art for Consumers (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrative Concept: 1)	
AHRM 2014	Design for Consumers Studio (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrative Concept: 1)	
COMM 2004	Public Speaking (Pathways Concept 1 - Discourse (advanced/applied); Integrative Concept 10)	
CS 1014	Introduction to Computational Thinking (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Concept 10)	
ENGE 1644	Global STEM Practice: Leadership and Culture (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: 11)	
ENGE 2524	Exploring Service Learning Through STEAM/STEM Educational Outreach	
ENGE 4104	Applied Explorations in Innovation	
ENGE 4735	Interdisciplinary Design Capstone	
ENGL 1654	Introduction to Science Fiction and Fantasy (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Concept 11)	
ENGL 3764	Technical Writing (Pathways Concept 1 - Discourse (advanced/applied); Integrative Concept: 10)	
ENGL 3774	Business Writing	
ENGL 3814	Creating User Documentation	
ENGL 3824	Visual Rhetoric and Document Design	
ENGL 3834	Intercultural Issues in Professional Writing	
ENGL 3844	Writing and Digital Media	
ENGL 4804	Grant Proposals and Reports	
ENGL 4814	Developing Online Content	
ENGL 4824	Science Writing	
HIST/STS 2715	History of Technology (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: 11)	
HIST/STS 2716	History of Technology (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: 11)	
ISE 4004	Theory of Organization	
ISE 4015	Management Systems Theory, Applications, and Design	
ISE 4304	Global Issues in Industrial Management	
STS/HIST 2054	Engineering Cultures	
STS 2154	The Life Sciences and Society (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Concept 10)	
STS 2354		
STS 3284	Technology and Disability (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrative Concept 10)	
STS 3334	Energy and Society (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept 11)	
Subtotal		9
Total Credits		**18**

Graduation Requirements

Minimum GPA: A minimum minor GPA of a 2.0 in each course taken to fulfill the minor is required.

Graduation Requirement: Students must achieve a grade of C or higher in all courses taken for the minor (ENGE 2094 , STS 2254, ENGE 4094, and any three courses taken from (ACIS 1004, AHRM 1014, AHRM 2014, COMM 2004, CS 1014, ENGE 1644, ENGE 2524, ENGE 4104, ENGE 4735, ENGL 1654, ENGL 3764, ENGL 3774, ENGL 3814, ENGL 3824, ENGL 3834, ENGL 3844, ENGL 4804, ENGL 4814, ENGL 4824, HIST 2715 or STS 2715, HIST 2716 or STS 2716, ISE 4004, ISE 4015, ISE 4304, STS 2054 or HIST 2054, HIST 2354, HIST 3284, HIST 3334)

Electives: A minimum of 3 credits of electives must be at the 3000-4000 level.

Integrated Security (ISDA) Minor

Please Note: There are 3 options to choose from in the Integrated Security Pathways Minor. All students in all 3 options will take the introductory and Capstone courses together. This minor is open to all

students regardless of major. **Tracks are denoted below by A - General Security Track, B - Securing Cyber Track, C - Human Security Track.**

Also note: no more that 50% of the graded course credit hours required for the Minor in Integrated Security may be double-counted by a student also enrolled in his/her major.

The Integrated Security Minor requires a minimum of 18-21 hours depending on minor track listed below:

Code	Title	Credits
I. Introductory Course		
BIT/CS/PSCI 2164	Foundations of Contemporary Security Environments (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) ; Pathways Concept 3 - Reasoning in the Social Sciences ; Intercultural Global Awareness) [1]	3
Subtotal		3
II. Middle Courses		
Select one of the following:		12-15
A. General Security Track		
B. Securing Cyber Track		
C. Human Security Track		
Subtotal		12-15
III. Capstone Course		
BIT/CS/PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems (Pathways Concept 1 - Discourse ; Ethics) [1,2]	3
Subtotal		3
Total Credits		**18-21**

[1] Pathways courses

[2] Courses with prerequisites. Please consult the University Course Catalog, or check with your advisor.

Tracks

A. General Security Track

Code	Title	Credits
Select one course from each block		
Block 1		
CS 1014	Introduction to Computational Thinking (Pathways Concept 5 - Quantitative and Computational Thinking)	3
CS 1054	Introduction to Programming in Java	3
CS 1064	Introduction to Programming in Python	3
CS 1114	Introduction to Software Design	3
SOC 2104	Quantitative Approaches to Community Research (Pathways Concept 5 - Quantitative and Computational Thinking) [1]	3
STS/HIST/SOC 2604	Introduction to Data in Social Context (Pathways Concept 2 - Critical Thinking in the Humanities) [1]	3
HD 3024	Community Analytics (Advanced/Applied Pathways Concept 5 - Quantitative and Computational Thinking) [1]	3
BIT 4604	Data Governance, Privacy and Ethics (Pathways Concept 2 - Critical Thinking in the Humanities) [1,2]	3
Block 2 (Human Security)		
HIST 1354	Conflict and Security in Modern East Asia (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
PSVP 2044	Peace and Violence (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PSCI 3104	Security Studies: Theories and Concepts [1]	3
PSCI 3114	Global Security [2]	3
PSCI 3134	Global Conflict and War	3
PSCI 3184	Human Security [2]	3
HIST 3714	War and Medicine	3
BIT 4604	Data Governance, Privacy and Ethics [2]	3
Block 3 (Cybersecurity)		
HIST 2716	History of Technology (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
PSCI 3044	The Politics of Internet Governance [2]	3
PSCI 3054	The Dark Web and Threat Analytics	3
PSCI 4074	The Politics of Cybersecurity [2]	3
FIN 4014	Cyberlaw and Policy (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
BIT 4614	Cybersecurity Management II [2]	3
ECE 4560	Computer and Network Security Fundamentals [2]	3
CRIM 4474	Cyber Criminology (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
CS 4264	Principles of Computer Security [2]	3
Block 4 (Environmental Security)		
AAEC 1264	(Pathways Concept 3 - Reasoning in the Social Sciences)	3
AAEC 3324	Environment and Sustainable Development Economics (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States) [1]	3
GEOS 1034	Earths Natural Hazards (Pathways Concept 4 - Reasoning in the Natural Sciences) [1,2]	3
GEOG 2004	Water, Environment, and Society (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
GEOG 2034	Geography of Global Conflict	3
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities) [1]	3

[1] Pathways courses.

[2] Courses with prerequisites. Please consult the University Course Catalog, or check with your advisor.

B. Securing Cyber Track

Code	Title	Credits
Select one course from each block		
Block 1 (Cybersecurity Infrastructure)		
CS 1014	Introduction to Computational Thinking (Pathways Concept 5 - Quantitative and Computational Thinking (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))) [1]	3
CS 1064	Introduction to Programming in Python	3
CS 1054	Introduction to Programming in Java	3
CS 1114	Introduction to Software Design	3
Block 2 (Cybersecurity and Society)		
CRIM 4474	Cyber Criminology (Pathways Concept 3 - Reasoning in the Social Sciences ; Ethical Reasoning) [1]	3
GEOG 2034	Geography of Global Conflict	3
HIST 2716	History of Technology (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
PSCI/IS 3054	The Dark Web and Threat Analytics	3
PSCI 4074	The Politics of Cybersecurity [2]	3
Block 3 (Cybersecurity Risk and Governance)		
FIN 4014	Cyberlaw and Policy (Pathways Concept 3 - Reasoning in the Social Sciences or Pathways Concept 2 - Critical Thinking in the Humanities ; Ethical Reasoning) [1]	3
BIT 4604	Data Governance, Privacy and Ethics (Pathways Concept 2 - Critical Thinking in the Humanities ; Ethical Reasoning) [1,2]	3
BIT 4614	Cybersecurity Management II [2]	3
ECE 4560	Computer and Network Security Fundamentals [2]	3
BIT 4624	Cybersecurity Analytics for Business [2]	3
CS 4264	Principles of Computer Security [2]	3
Block 4		
Select one additional course from any of the above blocks in the Securing Cyber Track		3

1 Pathways courses.
2 Courses with prerequisites. Please consult the University Course Catalog, or check with your advisor.

C. Human Security Track

Code	Title	Credits
Select 9 credit hours from Block 1, 6 credit hours from Block 2		
Block 1 (Foundations of Human Security)		
GEOG/IS/PSCI 2054	Introduction to World Politics (Pathways Concept 3 - Reasoning in the Social Sciences) [1]	3
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities ; Ethics) [1]	3
IS/PSCI 3184	Human Security [2]	3
Block 2 (Exploring Human Security)		
AAEC 1264	(Pathways Concept 3 - Reasoning in the Social Sciences)	3
PSVP 2044	Peace and Violence	3
GEOG 2034	Geography of Global Conflict	3
SOC 3004	Social Inequality [2]	3
IS/PSCI 3104	Security Studies: Theories and Concepts	3
IS/PSCI 3114	Global Security	3
IS/PSCI 3134	Global Conflict and War	3
IS/PSCI 3154	Topics in Global Public Policies	3
IS/PSCI 3175	Global Development	3
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
IS/PSCI 3634	Human Rights: Global Issues	3
HIST 3714	War and Medicine	3
IS 4014	International Development	3
IS/PSCI 4024	Seminar in Diplomacy and Security	3
SOC 4444	Schools, Violence, and Justice	3

1 Pathways courses.
2 Courses with prerequisites. Please consult the University Course Catalog, or check with your advisor.

Graduation Requirements

General Security Track Notes

- One course in addition to the two required courses must be a designated a Pathways course that meets a *third* Pathways objective. Example: If Foundations of Security is taken as a Pathways Computational Thinking course, and Security Solutions is taken as a Discourse Pathways course, then the student must choose his or her *third* Pathways course from the selected courses that meets a *third* Pathways objective, such as Reasoning in the Social Sciences, Critical Thinking in the Humanities, etc.
- In addition to the *Future of Security* course, 3 credit hours must be taken at the 3000/4000 level.
- No more than 50% of courses in the minor can be duplicated in the major.

Securing Cyber Track Notes

- One course in addition to the two required courses must be a designated Pathways course that meets a third Pathways objective. Example: If Foundations of Security is taken as a Pathways Computational Thinking course, and Security Solutions is taken as a Discourse Pathways course, then the student must choose his or her third Pathways course from the selected courses that meets a third Pathways objective such as Reasoning in the Social Sciences, Critical Thinking in the Humanities, etc.
- No more than 50% of courses can count towards the student's major.

Human Security Track Notes

- One elective must be taken at the 3000/4000 level.
- No more than 50% of the courses may be duplicated in the major.

Declaring a Minor and Advising

- Declare the Integrated Security Pathways Minor by emailing abrantly@vt.edu
- Please see an advisor in Political Science during pre-registration in 531 Major Williams for questions and assistance.
- Once a minor is declared, a student cannot graduate until she or he has either satisfied the requirements for the minor or withdrawn from

the minor by notifying the IS-DA academic advisors in 531 Major Williams Hall.

Integrative Health and Wellness (IHW) Minor

Code	Title	Credits
Required Minor Courses		
PHS 1514	Personal Health	3
HNFE 2334	Introduction to Integrative Health	3
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience	3
Subtotal		9
Restricted Electives		
Select 9 credits minimum of the following; 6 of these credits must be 3000 or 4000 level:		9
ADV 4324	Issues in Health Communication	
CMST 3124	Interpersonal Communication	
FST/HNFE 2544	Functional Foods for Health	
HD 2314	Human Sexuality	
HIST 3624	Health and Illness in African History	
HIST 3724	History of Disease, Medicine, and Health	
HNFE 4114	Food and Nutritional Toxicology	
HNFE 4224	Alternative and Complementary Nutrition Therapies	
HNFE 4354	Dietary Supplements and Health	
HORT/FREC 2134	Plants and Greenspaces in Urban Communities	
HORT 4794	Medicinal Plants and Herbs	
PHIL 3324	Biomedical Ethics	
PSYC 2054	Psychology of Personality	
PSYC 3024	Human Behaviors and Natural Environments	
PSYC 3054	Health Psychology	
RLCL 1024	Judaism, Christianity, and Islam	
RLCL 1904	Religion and Culture In Asia	
RLCL 2144	African Religions	
RLCL 3214	Religion and Culture in India	
SOC 4704	Medical Sociology	
SOC 4714	Sociology of Mental Illness	
STS/RLCL 2464	Religion and Science	
STS 3314	Medical Dilemmas and Human Experience	
XXXX 4964, 4974, or 4994	Field Study, Independent study or Undergraduate study [1]	
Subtotal		9
Total Credits		**18**

[1] May be included in the minor up to 3 credit hours (1 credit hour = 45 hours of work) when the topic is relevant to the Integrative Health and Wellness, as approved in advance by the minor coordinator and the course instructor, and/or the designated department undergraduate coordinator.

Seats in elective courses are not guaranteed.

Graduation Requirements

A minimum GPA of 2.0 in all courses taken to fulfill the minor is required. A faculty advisor in the College of Agriculture and Life Sciences (CALS) Academic Programs Office will serve as a counterpart to the student's major advisor. Students choosing the minor in Integrative Health and Wellness will register with the CALS Academic Programs Office, 1060 Litton Reaves Hall. This will enable the college to provide any pertinent assistance, materials, and information to the student. Some courses listed on this checksheet have prerequisites, please consult the University Course Catalog, or check with your advisor.

Interdisciplinary Engineering and Science (IES) Minor

Code	Title	Credits
Required Common Courses		
ENGR/COS 2164	Introduction to Scieneering	1
Select one of the following:		2
ENGR 2464	Engineering Fundamentals for Scientists (For Life Science majors) [1]	
BIOL 2124	Cell and Molecular Biology for Engineers (For Physical Science or Engineering majors) [2]	
ENGR/COS 4064	Scieneering Capstone	3
Subtotal		6
Elective Courses		
In-Discipline Courses		
Select 9 credit hours from the list based on a student's major		9
Out-Of-Discipline Courses		
Select 3 credit hours from the list based on a student's major		3
Subtotal		12
Total Credits		**18**

Elective Courses

In-Discipline

Code	Title	Credits
Life Sciences Majors [1]		
ALS 3104	Animal Breeding and Genetics	3
ALS 3304	Physiology of Reproduction	3
ALS/BIOL 4554	Neurochemical Regulation	3
ALS/WATR 4614	Watershed Assessment, Management, and Policy	2
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
BCHM 4784	Applications in Molecular Life Science	3
BIOL 3404	Introductory Animal Physiology	3
BIOL 3774	Molecular Biology	3
BIOL 4014	Environmental Toxicology	2
BIOL 4104	Developmental Biology	3
BIOL 4114	Global Change Ecology	3
BIOL 4164	Environmental Microbiology	3
BIOL 4564	Infectious Disease Ecology	3

BIOL 4624	Microbial Genetics	3
BIOL 4664	Virology	3
BIOL 4674	Pathogenic Bacteriology	3
BIOL 4704	Immunology	3
BIOL 4734	Inflammation Biology	3
BIOL 4824	Bioinformatics Methods	3
BIOL 4844	Proteomics and Biological Mass Spectrometry	3
BIOL 4854	Cytogenetics	3
BIOL 4874	Cancer Biology	3
BIOL 4884	Cell Biology	3
CHEM/ENSC 4734	Environmental Soil Chemistry	3
CSES/ENSC 4444	Managed Ecosystems, Ecosystem Services, and Sustainability	3
CSES 4644	Land-based Systems for Waste Treatment	3
CSES 4854	Wetland Soils and Mitigation	3
NANO 1015 & NANO 1016	Introduction to Nanoscience: From Atoms to Applications and Introduction to Nanoscience	6
FST 4504	Food Chemistry	3
FST 4634	Epidemiology Foodborne Disease	3
HNFE 3804	Exercise Physiology	3
HNFE 4844	Exercise and Neuromuscular Performance	3
PPWS 4114	Microbial Forensics and Biosecurity	3
PSYC 3024	Human Behaviors and Natural Environments	3
PSYC 4074	Sensation and Perception	3
PSYC 4114	Cognitive Psychology	3
SYSB 3035	Genomics and Bioinformatics	4
SYSB 3115	Network Dynamics and Cell Physiology	4
SYSB 3116	Network Dynamics and Cell Physiology	4
Engineering/Physical Sciences Majors [2]		
BSE 3154	Thermodynamics of Biological Systems	3
BSE 3504	Transport Processes in Biological Systems	3
BSE 3524	Unit Operations in Biological Systems Engineering	3
BSE 4524	Biological Process Plant Design	3
BSE/CHE 4544	Protein Separation Engineering	3
BSE 4604	Food Process Engineering	3
CEE 3104	Introduction to Environmental Engineering	3
CEE 3684	Civil Engineering Materials	4
CEE 4104	Water and Wastewater Treatment Design	3
CEE 4114	Fundamentals of Public Health Engineering	3
CEE 4174	Solid and Hazardous Waste Management	3
CEE 4614	Concrete Materials	3
CHE 3134	Separation Processes	3
CHE 3144	Mass Transfer	3
CHE 4014	Chemical Engineering Laboratory	5
CHE 4104	Process Materials	3
CHE 4185	Process and Plant Design	4
CHE 4186	Process and Plant Design	4
CHE 4214	Introduction to Polymer Materials	3
CHE 4334	Introduction to Colloidal and Interfacial Science	3
CHE/BSE 4544	Protein Separation Engineering	3
CHEM 4514	Green Chemistry	3
CHEM 4534	Organic Chemistry of Polymers	3
CHEM 4554	Drug Chemistry	3
CSES 4644	Land-based Systems for Waste Treatment	3
ECE 2164/ AOE 2664	Exploration of the Space Environment	3
ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	4
ECE 4364	Alternate Energy for Climate Sustainability	3
ECON 4014	Environmental Economics	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ENSC 3604	Fundamentals of Environmental Science	3
ENSC 3634	Physics of Pollution	3
ENSC 3644	Plant Materials for Environmental Restoration	3
ENSC/BIOL 4164	Environmental Microbiology	3
ENSC/CSES 4444	Managed Ecosystems, Ecosystem Services, and Sustainability	3
ENSC/CHEM 4734	Environmental Soil Chemistry	3
ENSC 4774	Reclamation of Drastically Disturbed Lands	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4204	Musculoskeletal Biomechanics [3]	3
ESM 4224	Biodynamics and Control	3
ESM 4234	Mechanics of Biological Systems	3
ESM 4304	Hemodynamics	3
GEOS 3014	Environmental Geosciences	3
GEOS 3034	Oceanography	3
GEOS 3104	Elementary Geophysics	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy (with lab)	3
GEOS 3604	Paleontology (with lab)	3
GEOS 3614/ CSES 3114	Soils (with lab)	3
GEOS/GEOG 4084	Modeling with Geographic Information Systems	3
GEOS 4634	Environmental Geochemistry	3
GEOS 4804	Groundwater Hydrology	3
ISE 3614	Human Factors Engineering and Ergonomics	3
ISE 3624	Industrial Ergonomics	3
ISE 4015	Management Systems Theory, Applications, and Design	3
ISE 4304	Global Issues in Industrial Management	3
ISE 4624	Physical Work Assessment	3
ISE 4644	Risk and Hazard Control	3
MATH 4564	Operational Methods for Engineers	3
MSE 2044	Fundamentals of Materials Engineering	4
MSE 2054	Fundamentals of Materials Science	3
MSE 3104/ GEOS 3504	Mineralogy	3
MSE 3134	Crystallography and Crystal Structures	3

MSE 3204	Fundamentals of Electronic Materials	3
MSE 3304	Physical Metallurgy	3
MSE 4164	Principles of Materials Corrosion	3
MSE 4304	Metals and Alloys	3
MSE 4414	Physical Ceramics	3
MSE 4574	Biomaterials	3
MSE 4584	Biomimetic Materials	3
NANO 1015 & NANO 1016	Introduction to Nanoscience: From Atoms to Applications and Introduction to Nanoscience	6
NANO 3015	Nanoscale Synthesis, Fabrication, and Characterization	4
NANO 3016	Nanoscale Synthesis, Fabrication, and Characterization	4
NANO 4124	Advanced Nanomaterials and Devices	3
NEUR 3044	Cellular and Molecular Neuroscience	3
NEUR 3084	Cognitive Neuroscience	3
NEUR 3144	Mechanisms of Learning and Memory	3
NEUR 3554	Neuroscience Research and Practical Experience	3
NEUR 3914	Neuroscience of Drug Addiction	3
NEUR 4034	Diseases of the Nervous System	3
NEUR 4454	Neuroeconomics	3
NEUR 4814	Nutritional Neuroscience	3
PHYS 4574	Nanotechnology	3
PHYS 4714	Introduction to Biophysics	3
SBIO 3004	Sustainable Nature-Based Enterprises	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SBIO 3454	Society, Sustainability Biomaterials and Energy	3
SBIO 3554	Sustainable Biomaterials Enterprises	3

Out-Of-Discipline

Code	Title	Credits
A. Life Sciences Majors [1]		
BIOL 4824	Bioinformatics Methods	3
BSE 3154	Thermodynamics of Biological Systems	3
CS 1044	Introduction to Programming in C	3
CS 1054	Introduction to Programming in Java	3
ECE 2164/ AOE 2664	Exploration of the Space Environment	3
ENGE 1354	Introduction to Spatial Visualization	1
ENGR 1814		3
ISE 2404	Deterministic Operations Research I	3
MATH 2214	Introduction to Differential Equations [4]	3
MATH 3214	Calculus of Several Variables	3
MSE 2034	Elements of Materials Engineering	3
STAT 3615	Biological Statistics	3
STAT 3616	Biological Statistics	3
STAT 4204	Experimental Designs	3
STAT 4214	Methods of Regression Analysis	3
B. Engineering/Physical Sciences Majors [3]		
ALS 2304	Comparative Animal Physiology and Anatomy	4
ALS/BIOL 2404	Biotechnology in A Global Society	3
BCHM 2024	Concepts of Biochemistry	3
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BIOL 2004	Genetics	3
BIOL/HORT 2304	Plant Biology	3
BIOL 2504	General Zoology	3
BIOL 2604	General Microbiology	3
BIOL 2804	Ecology	3
NANO 1015 & NANO 1016	Introduction to Nanoscience: From Atoms to Applications and Introduction to Nanoscience	6
CSES 4644	Land-based Systems for Waste Treatment	3
ECON 4014	Environmental Economics	3
ENSC 3604	Fundamentals of Environmental Science	3
GEOS 3014	Environmental Geosciences	3
GEOS 3034	Oceanography	3
GEOS 3104	Elementary Geophysics	3
GEOS 3404	Elements of Structural Geology	3
GEOS/CSES 3614	Soils (with lab)	3
GEOS/GEOG 4084	Modeling with Geographic Information Systems	3
GEOS 4634	Environmental Geochemistry	3
GEOS 4804	Groundwater Hydrology	3
HNFE 3804	Exercise Physiology	3
PHYS 4574	Nanotechnology	3
PHYS 4714	Introduction to Biophysics	3
PPWS 2104	Plants, Genes, and People	3

[1] Life Science majors include all CALS and CNRE majors not listed in Physical Sciences, as well as the COS majors of Biochemistry, Biological Sciences, Psychology, and Systems Biology.

[2] Will not count towards the IES minor for students majoring in Chemistry, Geological Sciences, Mathematics, Physics or Statistics.

[3] Physical Sciences include Chemistry, Economics, Environmental Sciences, Geosciences, Mathematics, Nanoscience, Neuroscience, Physics and Statistics and Sustainable Biomaterials.

[4] Will not count towards the IES minor for students majoring in Chemistry, Geological Sciences, Mathematics, Physics, or Statistics.

Graduation Requirements

1. To obtain a minor in Interdisciplinary Engineering and Science (Scieneering), a student must complete at least 18 credit hours on an A/F basis, as indicated below. A student must receive a grade of C or better for each course on this checksheet. A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.
2. Students completing the minor must obey all pre-requisite rules. Some courses above may have additional pre-requisites not required for minor.
3. Students may “double count” up to 9 credit hours in the minor with those required for graduation in their major, provided the major has no restrictions to the contrary. Out-of-discipline elective courses chosen for the minor cannot be required courses in the student’s major course of study.

International Business (IB) Minor

Code	Title	Credits
I. Required Culture Course (3 credits)		
Complete one of the following courses. Contact Pamplin International Programs if you think you may have taken a substitutable course.		
Select one of the following:		3
AFST 1814	Introduction to African Studies (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
ARBC 2774	Arab Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
ARBC 3274	War and Arab Culture (Pathways Concept 2 - Critical Thinking in the Humanities)	
ARBC 3474	Topics in Arab Cinema (Pathways Concept 2 - Critical Thinking in the Humanities)	
CHN 2734	Chinese Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities)	
CHN 3474	Topics in Chinese Cinema (Pathways Concept 2 - Critical Thinking in the Humanities)	
FR 2714	Introduction to French Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
GER 2724	Introduction to German Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
GER 3474	Topics in German Cinema (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 6 - Critique and Practice in Design and the Arts 6A)	
ITAL 3474	Topics in Italian Cinema (Pathways Concept 1 - Discourse 1A or Pathways Concept 2 - Critical Thinking in the Humanities)	
JPN 2744	From Atom to Akira: Japan's Pop Culture (Pathways Concept 2 - Critical Thinking in the Humanities)	
RUS 2734	Introduction to Russian Culture and Civilization (Pathways Concept 2 - Critical Thinking in the Humanities)	
RUS 4204	Topics in Russian Culture and Civilization	
RLCL 1904	Religion and Culture In Asia (Pathways Concept 2 - Critical Thinking in the Humanities)	
SPAN 2744	Topics in Spanish Culture (Pathways Concept 2 - Critical Thinking in the Humanities)	
SPAN 2754	Topics in Spanish American Culture (Pathways Concept 2 - Critical Thinking in the Humanities)	
SPAN 2764	Introduction to Latino American Studies (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
SPAN 2774	Minority Languages in the Spanish-Speaking Context (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
Subtotal		3
II. Required Elective Courses (9 credits)		
Select three of the following:		9
BIT 4474	Global Operations and Information Technology	
HTM 4484	International Tourism	
FIN 4144	International Financial Management	
MGT 4314	International Management (Junor Standing; fall only)	
MKTG 4704	International Marketing (Junior Standing)	
Subtotal		9
III. Restricted Elective Courses (6 credits)		
Students may take any two courses from the following but may not double count courses from Part II.		6
Any three-credit course from the list of International Business Minor Elective Courses below.		
Any three-credit course from the Department of Modern and Classical Languages and Literatures (FR, GER, SPAN, etc.) - cannot be used for Part I.		
Any one three-credit Pamplin Business Study Abroad course (ACIS, BIT, FIN, HTM, MGT, MKTG, or REAL 2954 or 3954). Other courses with an embedded study abroad experience may also fulfill the requirement - contact Pamplin International Programs for substitutions.		
Subtotal		6
IV. Foreign Language Requirement		
One of the following foreign language requirements must be met.		
a. Passed at least four years of a single foreign language in high school.		
b. Passed three years of a single foreign language in high school, plus two years of a different foreign language in high school. [1]		
c. Passed three years of a single foreign language in high school, plus two semesters of a university-level foreign language sequence (may be used in Part III above), e.g. SPAN 1105-SPAN 1106 or SPAN 1114 [1]		
d. Completion of a 2106 foreign language course - may take up to four semesters of a single university-level foreign language (e.g. FR 1105, FR 1106, FR 2105, FR 2106) (may be used in Part III above)		
e. Foreign language will be waived for international students or students that speak a second language in their home.		
V. International Experience Requirement		
If not a study abroad experience, the experience must be verified by Pamplin International Programs. All non-Pamplin students are required to complete a Pamplin study abroad experience in order to earn the minor.		
a. Study Abroad		
b. International Employment		
c. International Internship		
d. International Residency		
e. International Service Learning		
Total Credits		**18**

[1] If you choose a different language than high school, you may take any language at the 1000-level. Otherwise, you must take 2000-level courses.

International Business Minor Elective Courses

Code	Title	Credits
ARBC 3644	Religion in the Middle East (Pathways Concept 2 - Critical Thinking in the Humanities)	3
BIT 4474	Global Operations and Information Technology	3
ECON 4124	Growth and Development	3
FIN 4144	International Financial Management (Junior Standing)	3
GEOG 1014	World Regions (Pathways Concept 3 - Reasoning in the Social Sciences)	3
GEOG/IS/PSCI 2054	Introduction to World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
GEOG/IS/PSCI 2064	The Global Economy and World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
GEOG 3104	Environmental Justice, Resources and Development (Pathways Concept 3 - Reasoning in the Social Sciences)	3
GEOG 3254	Geography of East Asia	3
GEOG/SOC/UAP 4764	International Development Policy and Planning (Junior Standing)	3
HIST 1215	Intro to World History (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 1216	Intro to World History (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 1224	Mesoamerica and the Andes (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 1354	Conflict and Security in Modern East Asia (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 1515	History of Africa (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 1516	History of Africa (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 2124	Topics and Critical Issues in World History (Pathways Concept 2 - Critical Thinking in the Humanities)	3
HIST 2165		3
HIST 2166	History of France	3
HIST 2184	History of the Balkans	3
HIST 2345	History of the Middle East	3
HIST 2346	History of the Middle East	3
HIST 2355	History of China	3
HIST 2356	History of Modern China	3
HIST 2394	Tofu to Tikka: Food in Asian History (Pathways Concept 2 - Critical Thinking in the Humanities)	3
HIST 2484	Modern Germany (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 2724	Introduction to Displacement Studies (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
HIST 3394		3
HIST 3484	Nazi Germany: History and Memory	3
HIST 3554	Age of Globalization (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 3594	The Rise of Modern Latin America	3
HIST 3644	Twentieth-Century Russia	3
HIST 3654	Arab-Israeli Conflict (Pathways Concept 2 - Critical Thinking in the Humanities)	3
HIST 3664	Revolutionary China	3
HTM 2454	Global Travel & Tourism Management (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HUM/RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences)	3
IS/GEOG/PSCI 2054	Introduction to World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
IS/GEOG/PSCI 2064	The Global Economy and World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
JUD/RLCL/HIST 3494	The Holocaust	3
MGT 2204	Global Business of Pop Culture (Pathways Concept 2 - Critical Thinking in the Humanities and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
MGT 3094	Global Entrepreneurship (Pathways Concept 3 - Reasoning in the Social Sciences)	3
MGT 4314	International Management (Junior Standing)	3
MKTG 4704	International Marketing	3
MKTG 4404	Field Practicum in Marketing (Subject to approval; only international practicum experiences will be considered; may request a substitution for a minor elective)	3
PSCI/IS 1004	Nations and Nationalities (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
PSCI/IS/GEOG 2054	Introduction to World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PSCI/IS/GEOG 2064	The Global Economy and World Politics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PSCI/IS/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives (Pathways Concept 2 - Critical Thinking in the Humanities)	3
PSCI 3584	Governments and Politics of Asia	3
PSCI/IS 3615	International Relations	3
SBIO/FREC 2784	Global Forest Sustainability	3
UAP/GEOG/WGS 4214	Gender, Environment, and International Development (Junior Standing)	3

UAP/GEOG/SOC 4764	International Development Policy and Planning (Junior Standing)	3

Graduation Requirements

To complete the International Business minor, students must pass the 18 credits of required and elective classes listed with an average GPA of a 2.0 in these courses. Additionally, students must satisfy the foreign language and international experience requirements. No course grade may be lower than a C- to earn the minor. If these criteria are met, the minor will be noted on the student's transcript.

Application Eligibility

The International Business {IB) minor is open to all university students with a GPA of at least 2.0. However, all non-Pamplin students must complete a Pamplin international experience in order to earn the 1B minor. Additionally, all Real Estate and non-Pamplin students must complete HTM 2314 or MGT 2314 to be eligible to apply for the minor.

Students can apply for the IB minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Prerequisite Statement

Some courses listed on this check sheet have prerequisites; please consult the University Course Catalog or check with your academic advisor.

Requirements

No more than two courses from each discipline permitted, with the exception of XXXX 3954 Study Abroad. A course cannot be double-counted to meet more than one IB minor requirement unless indicated.

International Relations (IREL) Minor

Code	Title	Credits
Required Minor Courses		
Select one of the following:		3
PSCI 1024	Comp Gov & Politics	
PSCI 2014	Introduction to Political Theory	
Select one of the following:		3
IS/PSCI/GEOG 2054	Introduction to World Politics	
IS/PSCI/GEOG 2064	The Global Economy and World Politics	
Select one of the following:		3
IS/PSCI 3615	International Relations	
IS/PSCI 3616	International Relations	
Subtotal		9
Elective Courses		
Select nine (9) credit hours from the approved International Relations (IREL) Minor Elective List including a minimum of six (6) credit hours from 3000 and 4000 level courses.		9
Subtotal		9
Total Credits		**18**

Elective Courses for International Relations (IREL) Minor

Please note that not all courses are offered each semester. Check in the Undergraduate Course Catalog or with the department offering the course to find out when courses are offered.

International Studies (IS)

Code	Title	Credits
IS/PSCI 1114	Introduction to Transatlantic Studies	3
IS/PSCI/GEOG 2034	Geography of Global Conflict	3
IS/PSCI 2104	Europe Country Analysis	3
IS/PSCI 2114	Transatlantic Political Frameworks	3
IS/PSCI/GEOG 2134	Geography of the Global Economy	3
IS/PSCI/GEOG 2224	Geography of Europe	3
IS 2474	Religion and Violence	3
IS/PSCI 3374	The Politics of Energy	3
IS 3594	Topics in Middle East Politics and International Relations	3
IS 3615	International Relations	3
IS 3616	International Relations	3
IS/PSCI 3634	Human Rights: Global Issues	3
IS/PSCI 3804	European Integration	3
IS/PSCI 3814	The European Union: Institutions and Policies	3
IS/PSCI 3824	European Union's Foreign and Security Policy	3
IS/PSCI 3825	European Union's Foreign Relations	3
IS/PSCI 3826	European Union's Foreign Relations	3
IS/PSCI 3834	European Security Governance	3
IS/PSCI/GEOG 3844	European Geopolitics	3
IS/PSCI 3854	European Political Economy	3
IS/SOC 3884	Culture and Society in Contemporary Europe	3
IS/PSCI 3894	Transatlantic Relations Since 1945	3
IS/PSCI 3914	European Economics	3
IS/PSCI 3924	Theories of Transatlantic Relations	3
IS/PSCI 3934	NATO & European Security	3
IS/PSCI 4034	Topics in Diplomacy Lab	3
IS 4044	International Communication	3
IS 4104	Topics in European Studies	3
IS 4114	Topics in European Union Policies	3
IS 4124	Topics in European Integration	3
IS 4134	Capstone Research Project in European Studies	3
IS/PSCI 4144	Topics in Transatlantic Relations	3
IS/PSCI 4154	Topics in Transatlantic Studies	3
IS/PSCI 4184	Capstone Project Transatlantic Studies	3
IS/PSCI 4614	Senior Seminar in International Relations	3
IS/PSCI 4734	Theories and Practices of International Conflict Management	3
IS/PSCI 4735	Topics in Multilateral Diplomacy Workshop	3
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop	3

Political Science (PSCI)

Code	Title	Credits
PSCI 1024	Comp Gov & Politics	3
PSCI 2014	Introduction to Political Theory	3
PSCI/PHIL 3015	Political Theory	3
PSCI 3016	Political Theory	3
PSCI 3255	The Politics of Race, Ethnicity and Gender	3
PSCI 3256	The Politics of Race, Ethnicity and Gender	3
PSCI 3514	Latin American Government and Politics	3
PSCI 3515	European Political Systems	3
PSCI 3516	European Political Systems	3
PSCI 3524	Politics of Post-Communist Systems	3
PSCI 3534	African Government and Politics	3
PSCI/JUD/RLCL 3544	The State of Israel: A Political History	3
PSCI 3564	Violent Political Change	3
PSCI 3574	Government and Politics of Japan	3
PSCI 3584	Governments and Politics of Asia	3
PSCI/AINS 3684	Indigenous Peoples and World Politics	3
PSCI 3764	Contemporary Democratic Theory	3
PSCI/UAP 3774	Marxian Political Analysis	3
PSCI 3784	Origins of the State	3
PSCI 4514	Senior Seminar in Comparative Politics	3
PSCI 4724	Senior Seminar in Political Theory	3

Graduation Requirements

Hours Requirement: A minimum of 18 hours is required to graduate with an International Relations (IREL) minor.

GPA requirement: GPA of 2.0 is required for the IS minor. All courses listed on this checksheet are included in the International Relations minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Dual Use of Courses: Only required courses common across departmental majors and minors can double count.

Intra-departmental majoring and minoring: Due to overlapping of courses, students cannot pursue another major within the Department of Political Science. However, they can pursue any of the minors offered by the department except the Minor in Political Science.

International Studies (IS) Minor

Code	Title	Credits
Required Minor Courses		
Select one of the following:		3
IS/PSCI 1004	Nations and Nationalities	
IS/PSCI 1024	Comp Gov & Politics	
Select one of the following:		3
IS/PSCI/GEOG 2054	Introduction to World Politics	
IS/PSCI/GEOG 2064	The Global Economy and World Politics	
Select one of the following:		3
IS 3114	Global Security	
IS 3115	Selected World Problems	
IS 3116	Selected World Problems	
IS 3184	Human Security	
IS 3384	Politics of Global and Comparative Migration	
IS 3624	Foreign Policy and Diplomacy	
IS 3894	Transatlantic Relations Since 1945	
IS 4014	International Development	
Subtotal		9
Elective Courses		
Select 9 credit hours of elective courses (see below) [1,2]		9
Subtotal		9
Total Credits		**18**

1. At least 6 hours must be at the 3000 and/or 4000 level. Elective courses must be **either** in a single foreign language **or** from the courses listed below.
2. Other courses with an international character may also be considered. These courses will be evaluated for credit toward the minor by the International Studies Program advisor.

Elective Courses for International Studies (IS) Minor

Please note that not all courses are offered each semester. Check in the Undergraduate Course Catalog or with the department offering the course to find out when courses are offered.

Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

Africana Studies (AFST)

Code	Title	Credits
AFST 1814	Introduction to African Studies	3
AFST/RLCL 2144	African Religions	3
AFST/RLCL/WGS 2204	Race and Gender in Religion and Culture	3
AFST/SOC 2454	Race and Racism	3

Agricultural and Applied Economics (AAEC)

Code	Title	Credits
AAEC 1005	Economics of the Food and Fiber System	3
AAEC 1006	Economics of the Food and Fiber System	3
AAEC 1264		3
AAEC 3024	Monetary and Global Issues in Applied Economics	3
AAEC 3204	International Agricultural Development and Trade	3
AAEC 3324	Environment and Sustainable Development Economics	3
AAEC/ECON 4135	International Economics	3
AAEC 4204	Food and Agricultural Policy	3
AAEC 4324	Rural and Regional Development Policy	3
AAEC 4344	Sustainable Development Economics	3
AAEC/FREC 4464	Water Resources Policy and Economics	3

American Indian Studies (AINS)

Code	Title	Credits
AINS/HUM 2104	Oral Traditions and Culture	3
AINS/PSCI 3684	Indigenous Peoples and World Politics	3

Arabic (ARBC)

Code	Title	Credits
ARBC 2774	Arab Culture and Civilization	3
ARBC 3304	Modern Arabic Literature in Translation	3

Communication (COMM)

Code	Title	Credits
COMM 2084	Media and Society	3

Economics (ECON)

Code	Title	Credits
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
ECON 3004	Contemporary Economic Issues	3
ECON 3024	Economic Justice	3
ECON 3214	Money and Banking	3
ECON 4124	Growth and Development	3
ECON/AAEC 4135	International Economics	3
ECON 4136	International Economics	3
ECON 4144	Economics of China	3

French (FR)

Code	Title	Credits
FR 2714	Introduction to French Culture and Civilization	3
FR 3205		3
FR 3206		3
FR 3304	Introduction to French Literature	3
FR 3306		3
FR 3314	Introduction to Francophone Studies	3
FR 4314	Studies in French Literature	3
FR 4324	Special Topics in French Life, Literature and Language	3

Geography (GEOG)

Code	Title	Credits
GEOG 1004	Introduction to Human Geography	3
GEOG 1014	World Regions	3
GEOG/NR 1115	Seeking Sustainability	3
GEOG/NR 1116	Seeking Sustainability	3
GEOG 2004	Water, Environment, and Society	3
GEOG/IS/PSCI 2034	Geography of Global Conflict	3
GEOG/IS/PSCI 2134	Geography of the Global Economy	3
GEOG/IS/PSCI 3034	The CIA: Its Capabilities in Todays Geo-Political World	3
GEOG 3104	Environmental Justice, Resources and Development	3
GEOG 3254	Geography of East Asia	3
GEOG 3274	Polar Environments	3
GEOG 4054	Geography of Wine	3
GEOG 4074	Medical Geography of Infectious Diseases	3
GEOG 4204	Geography of Resources	3
GEOG/UAP/WGS 4214	Gender, Environment, and International Development	3
GEOG/SOC/UAP 4764	International Development Policy and Planning	3

German (GER)

Code	Title	Credits
GER 2724	Introduction to German Culture and Civilization	3
GER 3204	Culture of the German-Speaking Countries	3
GER 3305	Topics in German Culture and Literature	3
GER 3306	Topics in German Culture and Literature	3
GER 3474	Topics in German Cinema	3
GER 4304	Age of Goethe	3
GER 4314	Studies in 19th-Century Literature	3
GER 4324	Studies in 20th-Century Literature	3
GER 4334	Special Topics in German Life, Literature, and Language	3

History (HIST)

Code	Title	Credits
HIST 1025	Introduction to European History	3
HIST 1026	Introduction to European History	3
HIST 1214	History of the Modern World	3
HIST 1215	Intro to World History	3
HIST 1216	Intro to World History	3
HIST 1224	Mesoamerica and the Andes	3
HIST 1515	History of Africa	3
HIST 1516	History of Africa	3
HIST 2124	Topics and Critical Issues in World History	3
HIST 2165		3
HIST 2166	History of France	3
HIST 2184	History of the Balkans	3
HIST 2345	History of the Middle East	3
HIST 2346	History of the Middle East	3
HIST 2355	History of China	3
HIST 2356	History of Modern China	3
HIST 2364	History of Japan	3
HIST 3254	The Vietnam War	3
HIST 3324	The Medieval World	3
HIST 3334	The Renaissance World, 1350-1500	3
HIST 3344	Early Modern and Reformation History, 1500-1650	3
HIST 3364	The Age of Revolution and Napoleon	3
HIST 3394		3
HIST 3484	Nazi Germany: History and Memory	3
HIST/JUD/RLCL 3494	The Holocaust	3
HIST/RLCL 3504	The Age of The Crusades	3
HIST 3524		3

HIST 3534	Modern Military History	3
HIST 3544	World War II	3
HIST 3554	Age of Globalization	3
HIST 3594	The Rise of Modern Latin America	3
HIST 3614	Imperial Russia	3
HIST 3624	Health and Illness in African History	3
HIST 3644	Twentieth-Century Russia	3
HIST 3654	Arab-Israeli Conflict	3
HIST 3664	Revolutionary China	3
HIST 3674	Topics in Chinese History	3
HIST 3684		3
HIST 4004	Topics in Social and Cultural History	3

Humanities (HUM)

Code	Title	Credits
HUM 1324	Introductory Humanities: The Modern World	3
HUM/AINS 2104	Oral Traditions and Culture	3
HUM/RLCL 3204	Multicultural Communication	3

International Studies (IS)

Code	Title	Credits
IS/PSCI 4034	Topics in Diplomacy Lab	3

Italian (ITAL)

Code	Title	Credits
ITAL 3305	Introduction to Italian Literature in Context	3
ITAL 3306	Introduction to Italian Literature in Context	3
ITAL 3474	Topics in Italian Cinema	3

Journalism and Mass Communication (JMC)

Code	Title	Credits
JMC 4044	International Communication	3

Judaic Studies (JUD)

Code	Title	Credits
JUD/RLCL 2134	Judaism: A Survey of History, Culture, and Heritage	3
JUD/RLCL/HIST 3494	The Holocaust	3
JUD/PSCI/RLCL 3544	The State of Israel: A Political History	3
JUD 4424	Advanced Topics in Jewish Culture, History and Thought	3

Peace Studies and Violence Prevention (PSVP)

Code	Title	Credits
PSVP 2044	Peace and Violence	3
PSVP 4104	Global Society, Violence and the Prospects for Peace	3

Political Science (PSCI)

Code	Title	Credits
PSCI/IS 4034	Topics in Diplomacy Lab	3

Religion and Culture (RLCL)

Code	Title	Credits
RLCL 1004	Introduction to Religion and Culture	3
RLCL 1024	Judaism, Christianity, and Islam	3
RLCL 1034	Religion and the Modern World	3
RLCL 1044	Religious Ethics	3
RLCL 1214	The Medieval World	3
RLCL 1904	Religion and Culture In Asia	3
RLCL 2004	Case Studies in Religion and Culture	3
RLCL/SOC 2054	Ethnography: Studying Culture	3
RLCL/JUD 2134	Judaism: A Survey of History, Culture, and Heritage	3
RLCL/AFST 2144	African Religions	3
RLCL/AFST/WGS 2204	Race and Gender in Religion and Culture	3
RLCL 2324	Islam	3
RLCL/IS 2474	Religion and Violence	3
RLCL/WGS 3014	Women and Gender in Islam	3
RLCL/HUM 3204	Multicultural Communication	3
RLCL 3214	Religion and Culture in India	3
RLCL 3224	Religion and Culture in China and Japan	3
RLCL/JUD/HIST 3494	The Holocaust	3
RLCL/HIST 3504	The Age of The Crusades	3
RLCL/PSCI/JUD 3544	The State of Israel: A Political History	3
RLCL/SOC 4024	Sociology of Religion	3
RLCL 4324	Topics in Religion and Culture	3

Russian (RUS)

Code	Title	Credits
RUS 2734	Introduction to Russian Culture and Civilization	3
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation	3
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation	3
RUS/ENGL 3424	Topics in Russian Literature in English	3
RUS 4204	Topics in Russian Culture and Civilization	3
RUS 4304	Studies in Russian Literature	3

Sociology (SOC)

Code	Title	Credits
SOC 1004	Introductory Sociology	3
SOC 1014	Introduction to Social Anthropology	3
SOC 2004	Social Problems	3
SOC 2034	Diversity and Community Engagement	3
SOC/RLCL 2054	Ethnography: Studying Culture	3
SOC/AFST 2454	Race and Racism	3
SOC 3004	Social Inequality	3
SOC 3014	Gender Relations	3
SOC 3504	Population Trends and Issues	3
SOC 3854	Globalization: Sociological Perspectives	3
SOC/RLCL 4024	Sociology of Religion	3
SOC 4044	Military Sociology	3

SOC 4124	Topics in Culture	3
SOC/GEOG 4764	International Development Policy and Planning	3

Spanish (SPAN)

Code	Title	Credits
SPAN 2744	Topics in Spanish Culture	3
SPAN 2754	Topics in Spanish American Culture	3
SPAN 2764	Introduction to Latino American Studies	3
SPAN 2774	Minority Languages in the Spanish-Speaking Context	3
SPAN 3304	Introduction to Hispanic Literature	3
SPAN 3404	Early Peninsular Culture and Literature	3
SPAN 3414	Topics in Modern Cultures of Spain	3
SPAN 3444	Topics in Early Spanish American Cultures	3
SPAN 3464	Topics in Modern Mexican and Central American Cultures	3
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures	3
SPAN 3484	Topics in Modern Andean and Southern Cone Cultures	3
SPAN 4304	Topics in Early Modern Literature and Culture	3
SPAN 4314	Studies in 18th and 19th Century Literature	3
SPAN 4324	Studies in 20th and 21st Century Hispanic Literature	3
SPAN 4334	Special Topics in Hispanic Life, Literature, and Language	3
SPAN 4344	Hispanic Literature and the Representation of History	3

Urban Affairs and Planning (UAP)

Code	Title	Credits
UAP 1024	Leadership, Service, and Public Problem Solving	3
UAP 2014		3
UAP 3014	Urban Policy and Planning	3
UAP 3224	Policy Implementation	3
UAP/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP/PSCI 3744	Public Policy Analysis	3
UAP/PSCI 3774	Marxian Political Analysis	3
UAP 4184	Community Involvement	3
UAP/WGS/GEOG 4214	Gender, Environment, and International Development	3
UAP 4264	Environmental Ethics and Policy	3
UAP/GEOG/SOC 4764	International Development Policy and Planning	3

Women and Gender Studies (WGS)

Code	Title	Credits
WGS/RLCL/AFST 2204	Race and Gender in Religion and Culture	3
WGS 3014	Women and Gender in Islam	3
WGS 3214	Global Feminisms	3
WGS/GEOG/UAP 4214	Gender, Environment, and International Development	3

Graduation Requirements

Hours Requirement: A minimum of 18 hours is required to graduate with an International Studies (IS) minor.

GPA requirement: GPA of 2.0 is required for the IS minor. All courses listed on this checksheet are included in the IS minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Dual Use of Courses: No course can double count within or between International Studies-related majors or minors with the exception of the Core Degree Requirements and IS 1004 Nations and Nationalities, IS 2054 Introduction to World Politics and IS 2064 The Global Economy and World Politics.

Intra-IS Program majoring and minoring: Students may pursue more than one major or minor associated with the International Studies Program. In this case, the policy pertaining to the "Dual Use of Courses" will apply.

Intra-departmental majoring and minoring: Students pursuing one or more majors associated with the International Studies Program cannot major or minor in Political Science.

Italian (ITAL) Minor

Code	Title	Credits
Required Minor Courses		
Select six of the following:		18
ITAL 2105	Intermediate Italian [1]	
ITAL 2106	Intermediate Italian [1]	
ITAL 3105	Culture Composition and Conversation	
ITAL 3106	Culture Composition and Conversation	
ITAL 3305	Introduction to Italian Literature in Context	
ITAL 3306	Introduction to Italian Literature in Context	
ITAL 3474	Topics in Italian Cinema	
Total Credits		**18**

[1] Students who place out of ITAL 2105 and/or ITAL 2106 should take any Italian course at the 3000 or 4000 level to satisfy those credit requirements.

Graduation Requirements

18 credit hours in Italian at the 2000-level and above.

- A student must complete all courses with a least a minimum 2.0 Minor GPA for all hours attempted. In addition, a minimum grade of “C” (2.0) must be earned in each course completed for the Italian minor.
- Courses used to fulfill minor requirements may not be taken as Pass/Fail.
- All courses in the minor requirements listed above have prerequisites, so students should consult the University Catalog or check with their advisor to ensure the proper fulfillment of course requirements.
- Before the student departs on a study abroad program, a form titled “Authorization to Take Courses Elsewhere” must be filled out and signed by the student, the student's Italian advisor, and the Director of the Office of Global Education. The completed form must be

submitted to the dean of the College of Liberal Arts and Human Sciences.

- Independent Study in Italian (ITAL 4974) or Special Study in Italian (ITAL 3984) may be substituted if the topic is fitting. See your advisor for Italian.
- Topics in Italian Cinema (ITAL 3474) may be counted for the Italian minor a maximum of two times if taken with different content.
- Substitutions may be approved by the Italian Program Director upon request.

Japanese Studies (JPNS) Minor

Code	Title	Credits
Required Minor Courses		
JPN 2105	Intermediate Japanese	3
JPN 2106	Intermediate Japanese	3
JPN 3105	Advanced Japanese	3
JPN 3106	Advanced Japanese	3
Subtotal		12
Elective Courses		
Select 6 semester hours of the following:		6
JPN 2744	From Atom to Akira: Japan's Pop Culture	
JPN 3125	Japanese for Oral Proficiency	
JPN 3126	Japanese for Oral Proficiency	
JPN 3304	Japanese Literature in Translation	
JPN 3724	Modern Japanese Culture and Society	
JPN 3954	Study Abroad	
JPN 4104	Japanese Advanced Grammar	
RLCL 1904	Religion and Culture In Asia	
RLCL 3224	Religion and Culture in China and Japan	
HIST 2364	History of Japan	
ART 3064	Arts of China and Japan	
PSCI 3574	Government and Politics of Japan	
PSCI 3584	Governments and Politics of Asia	
Subtotal		6
Total Credits		**18**

Graduation Requirements

Students must earn 18 JPN credits regardless of initial course placement.

Language courses must be taken in sequential order. For students with AP/IB credit or prior Japanese language experience, contact your Japanese advisor for placement.

Students with a proficiency level in Japanese that is too advanced for a given course will not be allowed to enroll in that course.

- A minimum grade of "C" must be earned in each course completed for the Japanese Studies minor. A minimum in-minor GPA of 2.0 is required, and all courses used to fulfill the requirements of the minor will be used to determine the minor GPA.
- Courses used to fulfill minor requirements may not be taken Pass/Fail.
- A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the Chair of the Department, and the Director of the Office of Global Education before the student departs on a study abroad program.

Judaic Studies (JUD) Minor

Code	Title	Credits
Required Minor Courses		
JUD 2134	Judaism: A Survey of History, Culture, and Heritage	3
RLCL/JUD 2414	Hebrew Bible/Old Testament	3
Subtotal		6
Elective Courses		
Select 12 credits of the following: [1]		12
HEB/JUD 1105	Elementary Modern Hebrew	
HEB/JUD 1106	Elementary Modern Hebrew	
HIST 2345	History of the Middle East	
HIST 2346	History of the Middle East	
JUD/RLCL 3404	Torah and Tradition	
JUD/HIST 3494	The Holocaust	
JUD/PSCI 3544	The State of Israel: A Political History	
HIST 3654	Arab-Israeli Conflict	
JUD 4424	Advanced Topics in Jewish Culture, History and Thought	
JUD 4974	Independent Study (max 3 credit hours)	
Subtotal		12
Total Credits		**18**

[1] Including at least 6 credits at the 3000 level or above

Graduation Requirements

Special offerings, topics courses, Independent Study (4974), Special Study (4984), or Undergraduate Research (4994) in any department, so long as the topic is appropriate, may also be counted towards this minor. Permission to include courses not specifically listed here, however, must be granted by the minor coordinator. Please note that all upper division courses may require prerequisites. Students must take responsibility to familiarize themselves with any other prerequisites that may be required when selecting courses. Students must have an over-all GPA of 2.0 and a GPA of 2.0 in courses completed for the minor in order to graduate. For more information, contact the Judaic Studies Minor coordinator, Prof. Brian Britt, bbritt@vt.edu.

Landscape Architecture (LAR) Minor

Code	Title	Credits
Required Minor Courses		
Complete the following:		
LAR 1254	Environment and Natural Systems (Pathways Concept 4 - Reasoning in the Natural Sciences or Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	3

LAR 1264	Seeing, Understanding and Representing Landscape and the Built Environment (Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) or Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	3
LAR 2254	Social and Cultural Landscapes	3
Subtotal		9
Select a minimum of nine (9) credits of the following:		9
LAR/FREC/NR 2554	Leadership for Global Sustainability (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	
LAR 3044	Land Analysis and Site Planning (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	
LAR 3264	People Community and Place (Pathways Concept 3 - Reasoning in the Social Sciences)	
LAR 4034	Evolution of the American Landscape (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) or Pathways Concept 2 - Critical Thinking in the Humanities)	
LAR 4084	Landscape Design and Planning Studio (Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	
LAR 4154	Design Studies of the Built Environment (Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	
LAR 4254	Theories of Landscape Architecture	
LAR 4304	Topics in Landscape Architecture [1]	
LAR/BSE/FREC/HORT/SPIA 4554	Creating the Ecological City	
Subtotal		9
Total Credits		**18**

All courses taken for the LAR minor must be taken for an A-F grade and be completed with a minimum in-minor GPA of 2.0. Any courses taken for the LAR minor will count toward the in-minor GPA.

[1] May take different sections for credit

- Of the courses listed in Section 2, at least six (6) credits must be taken at the 3000 or 4000 level.
- All courses taken for the LAR minor must be taken for an A-F letter grade and be completed with a minimum in-minor GPA of 2.0. Any courses taken for the LAR minor will count towards the in-minor GPA.

Language and Culture for the Practice of Science (LCPS) Minor

Code	Title	Credits
Introduction/Foundational Experience		
Select one of the following:		6
FR 3105 & FR 3106	Composition, Conversation and Grammar and Composition, Conversation and Grammar [1]	
SPAN 3105 & SPAN 3106	Grammar, Composition and Conversation and Grammar, Composition and Conversation [1]	
Subtotal		6
Mid-level Experience		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Select one of the following:		2-4
ALS 2404	Biotechnology in A Global Society	
ALS 3404	Ecological Agriculture: Theory and Practice	
ALS 4204	Concepts in Community Food Systems	
APSC 3334	Animal Welfare and Bioethics	
BIOL 1064	Plants and Civilization	
ENT 2004	Insects and Human Society	
FIW 4464	Human Dimensions of Fisheries and Wildlife	
FIW 4714	Fisheries Management	
FREC 2124	Forests, Society & Climate	
FREC 2134	Plants and Greenspaces in Urban Communities	
FREC 2554	Leadership for Global Sustainability	
FREC 4334	Principles and Practice of Agroforestry	
HNFE 3634	Epidemiologic Concepts of Health and Disease	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2224	Horticulture Science and Industry	
PPWS 2104	Plants, Genes, and People	
PPWS 4114	Microbial Forensics and Biosecurity	
Select one of the following:		3
FR 2714	Introduction to French Culture and Civilization	
SPAN 2744	Topics in Spanish Culture	
SPAN 2754	Topics in Spanish American Culture	
SPAN 2764	Introduction to Latino American Studies	
SPAN 2774	Minority Languages in the Spanish-Speaking Context	
Subtotal		11-13
Capstone Experience		
Select one of the following:		3
FR 3154	French for the Natural Sciences	
SPAN 3154	Spanish for the Natural Sciences	
Subtotal		3
Total Credits		**20-22**

[1] The prerequisite for FR 3105/SPAN 3105 and FR 3106/SPAN 3106 can be satisfied through completing FR 2106/FR 2164 or SPAN 2106. It can also be met through high school study of French or Spanish and through AP or IB credit. Students with high school study of French or Spanish should consult with an advisor in the appropriate language to determine placement.

Graduation Requirements

Minor requirement: Minimum of 20 credit hours to complete minor.

Minimum GPA: A minimum GPA of 2.0 in these courses is required to complete the minor.

Prerequisite Statement: Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog, or check with your advisor.

Double Counting: No more than 50% of the graded course credits required for Minor in Language and Culture for the Practice of Science (LCPS) may be double-counted in a student's Major.

Language Sciences (LNGS) Minor

Code	Title	Credits
I. Required Minor Courses		
ENGL 1504	Introduction to Contemporary Linguistics (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: Intercultural Awareness)	3
Select one of the following:		3
ENGL/WGS 3134	Gender and Linguistics (Pathways Concept 1 - Discourse (advanced/applied); Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: Intercultural Awareness)	
ENGL/RLCL/SOC 3144	Language and Ethnicity in the United States (Pathways Concept 1 - Discourse (advanced/applied); Integrative Concept: Intercultural Awareness)	
SPAN 2774	Minority Languages in the Spanish-Speaking Context (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: Intercultural Awareness)	
ENGL 4074	Syntax (Pathways Concept 5 - Quantitative and Computational Thinking (advanced); Integrative Concept: Intercultural Awareness)	3
or ENGL 4144	Phonology	
Subtotal		9
II. Elective Courses		
Select two of the following: [1]		6
ENGL 1514	Language and Society (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concept: Ethical Reasoning ; Integrative Concept: Intercultural Awareness)	
ENGL 1524	Language and the Mind	
ENGL 2034	Analyzing the Sounds of Language (Pathways Concept 5 - Quantitative and Computational Thinking (foundational); Integrative Concepts: Ethical Reasoning)	
ENGL/AINS 3304	The Languages of Native America	
RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Concepts: Intercultural Awareness)	
ENGL 4004	Linguistic Discourse Analysis	
ENGL 4054	History of the English Language	
GER 4334	Special Topics in German Life, Literature, and Language [2]	
ENGL/PSYC 4134	Language Development	
SPAN 3494	Introduction to Hispanic Linguistics	
SPAN 3544	Sounds of Spanish	
SPAN 4114	Topics in Spanish Linguistics	
ENGL 4974	Independent Study [3]	
or CHN 4974	Independent Study	
or CLA 4974	Independent Study	
or FL 4974	Independent Study	
or GER 4974	Independent Study	
or GR 4974	Independent Study	
or HEB 4974		
or ITAL 4974	Independent Study	
or JPN 4974	Independent Study	
or LAT 4974	Independent Study	
or PORT 4974	Independent Study	
or SPAN 4974	Independent Study	
Subtotal		6
Language Sciences Capstone		
ENGL 4084	Conducting Research in the Language Sciences	3
Subtotal		3
Total Credits		**18**

[1] Courses in Section I not taken as required may be used as electives.
[2] GER 4334 counts as an elective only when History of the German Language is the topic.
[3] An independent study on an appropriate linguistic topic as approved by a linguistics faculty member.

Graduation Requirements

The Pathways Minor in Language Sciences requires 18 hours.

Some courses on this checksheet have prerequisites. Please consult the University Catalog or your advisor.

In order to graduate with a Minor in Language Sciences, students must complete all courses comprising the minor with a GPA of 2.0 or better.

Latin (LAT) Minor

Code	Title	Credits
Required Minor Courses		
Select 18 semester hours of the following:		18
LAT 1105	Elementary Latin	
LAT 1106	Elementary Latin (cont.)	
LAT 2104	Cicero and Livy	
LAT 2114	Latin Epic: Vergil and Ovid	
LAT 2124	Latin Lyric: Catullus and Horace	
LAT 2134	Late Medieval Latin	
LAT 2984	Special Study	
LAT 3004	Readings in Latin Literature	
LAT 4004	Directed Studies in Latin Prose Composition	
LAT 4974	Independent Study [1]	
LAT 4984	Special Study (Advanced)	
LAT 4994	Undergraduate Research [1]	
LAT 5974	Independent Study [1]	
LAT 5984	Special Study (Graduate)	

LAT 5994	Research and Thesis [1]	
Subtotal		18
Total Credits		**18**

[1] Courses can be included in the Minor *only* with permission of your advisor.

Graduation Requirements

Requirements: 18 semester hours of coursework in Latin from the following list, including at least 6 credit hours at the 3000 or 4000 level. With the exception of LAT 1105 Elementary Latin , LAT 1106 Elementary Latin , and LAT 4004 Directed Studies in Latin Prose Composition all courses are variable-content courses and may be repeated for credit up to three times with different content. For substitutions, see your advisor for Latin.

- All courses taken from among those listed above will be included in the calculation of the minor GPA.
- A student must complete all courses with a minimum 2.0 GPA for all hours attempted. In addition a minimum grade of C is required of all Foreign Language Minors in each of the required courses for the minor.
- Required courses may be transferred only with the approval of your advisor for the Latin Minor.
- Authorization to take coursework elsewhere should be obtained beforehand from the Dean's Office and the Chair of Modern and Classical Languages and Literatures.

N.B.

1. CLA 2444 Ancient Greek and Roman Mythology (= ENGL 2444 Ancient Greek and Roman Mythology and RLCL 2444 Greek and Roman Myth) and CLA 2454 Topics in Ancient Greek and Latin Literature do not count toward a Latin Minor.
2. No course required for the Latin Minor may be taken Pass/Fail.

Leadership and Service (LAS) Minor

Code	Title	Credits
Required Minor Courses		
Select 12 credit hours of the following:		12
AS 3215	Air Force Management and Leadership (AFROTC label: Leading People and Effective Communication) [1]	
AS 3216	Air Force Management and Leadership (AFROTC label: Leading People and Effective Communication) [1]	
AS 4215	National Security Forces in Contemporary American Society (AFROTC label: National Security, Leadership Responsibilities, and Commissioning Preparation) [1]	
AS 4216	National Security Forces in Contemporary American Society (AFROTC label: National Security, Leadership Responsibilities, and Commissioning Preparation) [1]	
MS 1006	Military Science I, Army Reserve Officer Training Corps	
MS 2005	Military Science II, Army Reserve Officer Training Corps [1]	
MS 3006	Military Science III, Army Reserve Officer Training Corps [1]	
MS 4006	Military Science IV, Army Reserve Officer Training Corps [1]	
Subtotal		12
Elective Courses		
Select 9 credit hours of electives (see below)		9
Subtotal		9
Total Credits		**21**

[1] Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Elective Courses for Leadership and Service Minor

History (HIST)

Code	Title	Credits
HIST 3254	The Vietnam War	3
HIST 3484	Nazi Germany: History and Memory	3
HIST 3644	Twentieth-Century Russia	3
HIST 3524		3
HIST 3534	Modern Military History	3
HIST 3544	World War II	3

Philosophy (PHIL)

Code	Title	Credits
PHIL 1304	Morality and Justice	3
PHIL 2304	Global Ethics	3
PHIL 3314	Ethical Theory [1]	3
PHIL/MGT 4324	Business and Professional Ethics	3
PHIL 4334	Jurisprudence [1]	3

[1] Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Leadership Studies (LDRS)

Code	Title	Credits
LDRS 1414	Citizen Leadership	3
LDRS 2014	Principles of Peer Leadership	3
LDRS 3104	The Dynamics of Leadership [1]	3
LDRS 3304	Elements of Team Leadership [1]	3

[1] Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Aerospace Studies (AS)

Code	Title	Credits
AS 1115	Introduction to the Air Force (AFROTC label: Heritage and Values) [1]	1

AS 1116	Introduction to the Air Force (AFROTC label: Heritage and Values)	1
AS 2115	Team and Leadership Fundamentals (AFROTC label: Team Leadership and Fundamentals) [1]	1
AS 2116	Team and Leadership Fundamentals (AFROTC label: Team Leadership and Fundamentals)	1
AS 2944	AFROTC Leadership Laboratory (1, can be counted up to 8 times) [1]	1

[1] Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Military Science (MS)

Code	Title	Credits
MS 1005	Military Science I, Army Reserve Officer Training Corps	2
MS 2006	Military Science II, Army Reserve Officer Training Corps [1]	3
MS 3005	Military Science III, Army Reserve Officer Training Corps [1]	4
MS 4005	Military Science IV, Army Reserve Officer Training Corps [1]	4

[1] Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Graduation Requirements

Hours requirement: A minimum of 21 hours is required to graduate with a Leadership and Service minor.

GPA requirement: A GPA of 2.5 is required for the minor. All courses listed on this checksheet are included in the minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites and/or corequisites. Be sure to consult the University Catalog and/or check with your advisor.

Double-counting: Any student pursuing multiple minor degree programs *may* use courses completed for other minor programs towards completion quotas for this minor (provided, of course, that the course in question is one listed on this checksheet as a requirement or elective).

Leadership and Social Change (ILRM) Minor

The Leadership and Social Change minor introduces students to the academic study of leadership and provides them with interdisciplinary skills to solve complex societal issues at the local, national, and international levels. While engaging in the study of leadership, students will also learn about the Social Change Model of Leadership Development created specifically for college students. This model helps students understand themselves (individual values), how to work with others (group values), and how to better serve their communities (society values). In this process, students will not only learn *about* leadership but will also answer the question: leadership *for what*?"

Admission Requirements for the Minor

The Leadership and Social Change minor is open to all Virginia Tech undergraduate students with a cumulative GPA of at least 2.50. To add the minor, visit this link: https://www.cals.vt.edu/academic-programs/current/CALS_Studentforms.html (https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cals.vt.edu%2Facademic-programs%2Fcurrent%2FCALS_Studentforms.html&data=05%7C02%7Cdagreen%40vt.edu%7C9cf843b7146f4b0156a908dcd7f04302%7C6095688410ad40fa863d4f32c1e3a3%7C0%7C0%7C638622674118081326%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLC%7C0%7C%7C%7C&sdata=yWV8cqPnEcpGZ%2F5T1T77fBme8MqXboxQ3v2DvWE6%2Fwc%3D&reserved=0), scroll down and select “Add or Drop Minor in CALS”.

Code	Title	Credits
Required Minor Courses		
LDRS 1414	Citizen Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	3
LDRS 4044	Leadership Studies Capstone	1
Select six credit hours of the following:		6
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations (Pathways Concept 3 - Reasoning in the Social Sciences)	
LDRS 2014	Principles of Peer Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	
LDRS 3104	The Dynamics of Leadership	
LDRS 3304	Elements of Team Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	
LDRS 4514	Skills for Nonprofit Organizational Leaders	
SS 4984	(Toxic Leadership)	
Social Change Electives Courses		**9**
Select nine credit hours of the following (three credit hours from each section):		
Communicating Individual Values		
ALCE 3624	Communicating Ag and Life Sciences in Writing (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A))	
ALCE 3634	Communicating Ag and Life Sciences in Speaking (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A))	
ALCE 2414	Identity and Inclusion in Agricultural and Life Sciences (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))	
ENGL 4804	Grant Proposals and Reports	
HD 2314	Human Sexuality	
HUM 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
LDRS 1424	Citizen Leadership Praxis (Pathways Concept 3 - Reasoning in the Social Sciences)	
LDRS 2964	Field Study (Field Study/Practicum)	
LDRS 3954	Study Abroad (Study Abroad)	

LDRS 4754	Internship
LDRS 4964	Field Study (Field Study/Practicum)
LDRS 4994	Undergraduate Research
MGT 3304	Management Theory and Leadership Practice (Study Abroad)
MKTG 3954	Study Abroad (Field Study/Practicum)
PSYC 1004	Introductory Psychology
Understanding Group Values	
AFST 1714	Introduction to African American Studies (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
AFST 1814	Introduction to African Studies (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)
AFST 2734	The Black Woman in the U.S.
AFST 3454	African American Leadership for Social Change
APS 1704	Introduction to Appalachian Studies (Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
HD 1134	Introduction to Disabilities Studies
HUM 3464	Appalachian Communities
MGT 2354	Teams, Leadership, and Business: Cultivating Excellence (Pathways Concept 3 - Reasoning in the Social Sciences)
MKTG 4154	Marketing Research
PSCI 3256	The Politics of Race, Ethnicity and Gender
PSCI 3264	
PSYC 2084	Social Psychology (Pathways Concept 3 - Reasoning in the Social Sciences)
RLCL 2204	Race and Gender in Religion and Culture (Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
SOC 2024	Sociology of Race and Ethnicity (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
SOC 2514	Asian American Experience (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
SOC 3614	Gender and Work in the U.S.
WGS 1824	Introduction to Womens and Gender Studies (Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03))
WGS 2114	Feminist Theory
WGS 2254	Feminist Activism
Supporting Societal/Community Values	
AAEC 1264	(Pathways Concept 3 - Reasoning in the Social Sciences)
AAEC 3324	Environment and Sustainable Development Economics (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
AFST 2354	The Civil Rights Movement
ALCE 4304	Community Education and Development
HD 3024	Community Analytics
MGT 4334	Ethical Leadership and Corporate Social Responsibility (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
MKTG 4644	Marketing, Society and the Public Interest
PHIL 1304	Morality and Justice (Pathways Concept 2 - Critical Thinking in the Humanities)
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)
PHIL 4304	Political Philosophy (Pathways Concept 2 - Critical Thinking in the Humanities)
PSCI 3214	Political Participation
RLCL 1044	Religious Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)
SOC 2004	Social Problems (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))
SOC 2034	Diversity and Community Engagement
SOC 3004	Social Inequality
SPIA 1024	Community Service Learning
SPIA 2554	Collaborative Policy-Making and Planning
UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives (Pathways Concept 2 - Critical Thinking in the Humanities)
Total Credits	**19**

Graduation Requirements

- A minimum of 19 hours is required to graduate with the Leadership and Social Change minor.
- Students must complete at least 6 credit hours of coursework at the 3000-level or above.
- At least 9 credits of Pathways courses must satisfy three different concepts.
- No more than 50% of the graded course credits required for the Minor in Leadership and Social Change (ILRM) may be double counted in a student's major.
- Students must self-select their social change electives based on an interest area or focus. Use the definitions provided on page 1 and the worksheet on page 3 for ideas. If you are interested in taking social change elective courses outside what is listed, please consult with

Dr. Austin Council, Coordinator of the Leadership and Social Change Minor (adc@vt.edu), before enrolling to receive approval.

Adding the Leadership and Social Change Minor

To add the minor, visit this link: https://www.cals.vt.edu/academic-programs/current/CALS_Studentforms.html, scroll down and select "Add or Drop Minor in CALS".

Leadership, Corps of Cadets (LMCC) Minor

Application to the Minor in Leadership - Corps of Cadets is restricted to active members of the Virginia Tech Corps of Cadets. Awarding of the Minor in Leadership - Corps of Cadets is restricted to graduates of the Virginia Tech Corps of Cadets.

Qualifying Leadership Positions for the LMCC

Regimental

- Commander
- Executive Officer
- Adjutant (S-1)
- Public Information (S-2)
- Operations Officer (S-3)
- Supply (S-4)
- Academics (S-5)
- Command Sgt Major
- Honor Court Chief Justice
- Vice Chief for Education
- Executive Committee Chairman
- Executive Committee Legal Officer
- Recruiting Officer
- Recruiting NCO
- Safety Officer
- Inspector General
- NCOIC Inspector
- Armorer
- Historian
- Athletics Officers
- Medical Officer
- Skipper Crew Gun Captain
- Skipper Crew OIC
- Color Guard Commander
- Gregory Guard Commander
- Conrad Cavalry Commander
- Scabbard and Blade Commander
- Chapel Liaison
- Hearing Officer

Battalion

- Commander
- Executive Officer
- VPI Director of Staff
- Adjutant (S-1)
- Public Information (S-2)
- Operations Officer (S-3)
- Supply (S-4)
- Academics (S-5)
- VPI Battalion PT Instructor
- Sgt Major
- Safety Officer
- NCOIC IG

Company

- Commander
- Executive Officer
- Platoon Leaders
- Academics Officer
- First Sergeant
- Platoon Sergeants
- Squad Leaders
- Safety Officer
- VPI Company PT Instructor
- Athletics NCO
- Cadre Sergeants
- Fire Team Leaders

Band

- Commander
- Executive Officer
- Drum Major
- Safety Officer
- Section Commander
- Platoon Leaders
- Academics
- Operations
- Finance
- Performance
- Public Information
- Supply
- First Sergeant
- Regimental Bugler
- Supply NCO
- Platoon Sergeants
- Squad Leaders
- Fire Team Leaders

Code	Title	Credits
I. Corps Leadership Courses		
Minimum of 6 semesters or 5 semesters for transfer students - credit hours vary [1]		5-10
MGT 1945	Fundamentals of Cadet Leadership	
MGT 1946	Fundamentals of Cadet Leadership	
MGT 2945	Small Unit Leadership for Cadets	
MGT 2946	Small Unit Leadership for Cadets	
MGT 3804	Topics for Cadet Global Leadership Studies	
MGT 3945	Cadet Organizational Leadership	
MGT 3946	Cadet Organizational Leadership	

MGT 3964	Field Study	
MGT 4945	Executive Leadership for Cadets	
MGT 4946	Executive Leadership for Cadets	
Subtotal		5-10
II. ROTC or Pro Lab		
Select 8 to 11 credits of the following: [1]		8-11
Pro Lab		
MGT 1935	Fundamentals of Cadet Professional Leadership	
MGT 1936	Fundamentals of Cadet Professional Leadership	
MGT 2935	Career Planning for Cadets	
MGT 2936	Career Planning for Cadets	
MGT 3935	Advanced Professional Development for Cadets	
MGT 3936	Advanced Professional Development for Cadets	
MGT 4935	Cadet Citizen Leader Practicum	
MGT 4936	Cadet Citizen Leader Practicum	
Army ROTC		
MS 1005	Military Science I, Army Reserve Officer Training Corps	
MS 1006	Military Science I, Army Reserve Officer Training Corps	
MS 2005	Military Science II, Army Reserve Officer Training Corps	
MS 2006	Military Science II, Army Reserve Officer Training Corps	
MS 3005	Military Science III, Army Reserve Officer Training Corps	
MS 3006	Military Science III, Army Reserve Officer Training Corps	
MS 4005	Military Science IV, Army Reserve Officer Training Corps	
MS 4006	Military Science IV, Army Reserve Officer Training Corps	
Navy ROTC		
MN 1004	Introduction to Naval Science	
MN 1104	Naval Ships Systems I: Engineering	
MN 2004	Naval Ships Systems II: Weapons	
MN 2104	Seapower and Maritime Affairs	
MN 3005	Navigation and Naval Operations	
MN 3006	Navigation and Naval Operations	
MN 3204	Evolution of Warfare	
MN 4005	Leadership and Management/Ethics	
MN 4006	Leadership and Management/Ethics	
MN 4204	Amphibious Warfare	
Air Force ROTC		
AS 1115	Introduction to the Air Force	
AS 1116	Introduction to the Air Force	
AS 2115	Team and Leadership Fundamentals	
AS 2116	Team and Leadership Fundamentals	
AS 3215	Air Force Management and Leadership	
AS 3216	Air Force Management and Leadership	
AS 4215	National Security Forces in Contemporary American Society	
AS 4216	National Security Forces in Contemporary American Society	
Subtotal		8-11
III. Required Minor Courses		
PHIL 2304	Global Ethics	3
Select one of the following:		3
MGT 3304	Management Theory and Leadership Practice	
MGT 3404	Principles of Management	
Substitute approved by the Director of the Rice Center for Leader Development (include signed LMCC Course Substitute Request)		
Subtotal		6
Total Credits		**19-27**

[1] Students must complete a minimum of 22 credit hours to earn the minor.

Graduation Requirements

Application to the Minor in Leadership - Corps of Cadets (LMCC) is restricted to active members of the Virginia Tech Corps of Cadets. Awarding of the Minor in Leadership - Corps of Cadets is restricted to students who have completed a minimum of six (6) semesters in the Virginia Tech Corps of Cadets. For more information about declaring the minor, visit https://vtcc.vt.edu/academic-programs/check-sheets.html.

Requirements for Minor

I. A minimum of 22 credit hours consisting of:

- Sixteen credit hours that include:
  - Satisfactory completion of a minimum of six semesters of Corps Leadership Courses. If a cadet transferred into the VTCC after their first year of college, then they will be required to satisfactorily complete the appropriate Corps Leadership Courses for a minimum of five semesters.
  - The remaining credits must be earned by satisfactory completion of ROTC or Pro Lab courses.
- Six credit hours must include:
  - Satisfactory completion of MGT 3304 Management Theory and Leadership Practice OR MGT 3404 Principles of Management OR suitable substitute approved by the Director of the Rice Center for Leader Development.
  - Satisfactory completion of PHIL 2304 Global Ethics
- A minimum of six credit hours at the 3000-level or above must be satisfactorily completed.
- Satisfactory completion of coursework for this minor is defined as earning no lower than a C- as the final grade for each course.

II. Satisfactory completion of leadership progression within the Virginia Tech Corps of Cadets:

- Requires satisfactory completion of three leadership positions that have direct supervisory responsibility over other cadets or significant organizational responsibility. (3 VTCC – or – 2 VTCC and 1 ROTC/VPI – or – 1 VTCC and 2 ROTC/VPI). The Director of the Rice Center for Leader Development maintains the current list of approved leadership positions: https://vtcc.vt.edu/academic-programs/check-sheets.html.
- Fire Team Leader (in any organization) can only be counted once.
- Must complete at least six semesters in the Corps of Cadets. Students dismissed from the Corps of Cadets for disciplinary reasons

or unsatisfactory performance are not eligible for this minor. This requirement is met upon graduation from the Corps of Cadets for transfers students enrolled in the Corps of Cadets for less than six semesters.

Pre-Requisite Statement

Some courses listed have pre-requisites, please consult the University Course Catalog, or check with your advisor.

Literature (LIT) Minor

Code	Title	Credits
Required Minor Courses		
I. A Course in Literature Written Before 1800		
Select one of the following:		3
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
Or an appropriate section of:		
ENGL 4684	Special Topics in Literature	
ENGL 4784	Senior Seminar	
II. A Course in Diverse Literary Traditions		
Select one of the following:		3
ENGL/AFST 2644	Introduction to African-American Literature	
ENGL/AINS 2804	Contemporary Native American Literatures	
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
III. Four Courses in Literature		
Select four of the following: [1]		12
ENGL 2034	Analyzing the Sounds of Language	
ENGL 2534	American Literary History	
ENGL 2544	British Literary History	
ENGL 2604	Introduction to Critical Reading	
ENGL/AFST 2644	Introduction to African-American Literature	
ENGL 2804	Contemporary Native American Literatures	
ENGL 3134	Gender and Linguistics	
ENGL 3144	Language and Ethnicity in the United States	
ENGL 3154	Literature, Medicine, and Culture	
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 3234	Romantic Literature	
ENGL 3244		
ENGL 3264	Modernist British Literature	
ENGL 3274		
ENGL 3324	Acts of Interpretation	
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL 3534	Literature and the Environment	
ENGL 3544	Literature and Cinema	
ENGL 3624	Appalachian Literature	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3684	Literature and the Law	
ENGL 3684H	Literature and the Law	
ENGL 3694	Topics in World Novels	
ENGL 3844	Writing and Digital Media	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
ENGL 4434	The American Novel	
ENGL 4444	The British Novel	
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4644	Studies in an American Author after 1900	
ENGL 4664	Contemporary Fiction	
ENGL 4674		
ENGL 4684	Special Topics in Literature	
Total Credits		**18**

Graduation Requirements

The Minor in English: Literature requires 18 hours distributed as follows:

I. A Course in Literature Written Before 1800 (3 hours)

II. A Course in Diverse Literary Traditions (3 hours)

III. Four Courses in Literature (12 hours)

In order to graduate with a Minor in Literature, students must complete all courses comprising the minor with a GPA of 2.0 or better

Materials in Society (MTSC) Minor

Instructions: Complete all classes in Section I (Core Requirements), three classes from Section II (Restricted Electives), and Section III (Materials and Society Capstone Requirement). 18 total credit hours are required to complete the minor. no more than 50% of the graded course credits required for the minor may be double-counted in a student's major.

Code	Title	Credits
I. Required Minor Courses		
MSE 1014	The Science of Materials in Everyday Life (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Ethical Reasoning)	3
CHEM 3054	Postconsumer Materials (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)	3
Subtotal		6

II. Restricted Electives		
Select three credits from each of the following sections for a total of nine credits:		9
IIa: Social Equity		
PHIL 1304	Morality and Justice (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Ethical Reasoning)	
STS 2454	Science, Techology, and Environment (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcomes: Intercultural and Global Awareness; Ethical Reasoning)	
STS 3334	Energy and Society (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
STS 3284	Technology and Disability (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrative Outcome: Ethical Reasoning)	
ENGL 2634	Writing and Social Justice (Pathways Concept 1 - Discourse (advanced/applied) and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning)	
IIb: Policy		
STS 2444	Global Science and Technology Policy (Pathways Concept 2 - Critical Thinking in the Humanities ; Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
SPIA 2554	Collaborative Policy-Making and Planning (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning)	
SPIA 4464	Data and the Art of Policy-Making and Planning (Pathways Concept 5 - Quantitative and Computational Thinking (advanced/applied); Integrative Outcome: Ethical Reasoning)	
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework (Pathways Concept 1 - Discourse (advanced/applied) or Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Ethical Reasoning)	
FREC/AAEC/WATR 4464	Water Resources Policy and Economics (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrative Outcome: Ethical Reasoning)	
IIc: Materials Science		
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
CHEM 1015	Chemistry in Context (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Ethical Reasoning) [1]	
CHEM 1016	Chemistry in Context (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Ethical Reasoning) [1]	
GEOS 1024	Earth Resources, Society, and Environment (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
ENSC 1015	Foundations of Environmental Science (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
ENSC 1016	Foundations of Environmental Science (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Intercultural and Global Awareness)	
GEOS 1004	Earth Science: Our Past, Present, and Future (Pathways Concept 4 - Reasoning in the Natural Sciences ; Integrative Outcome: Ethical Reasoning)	
Subtotal		9
III. Materials and Society Capstone Requirement		
CHEM 4054		3
Subtotal		3
Total Credits		**18**

1 Prior credit in CHEM 1035 General Chemistry or CHEM 1036 General Chemistry can substitute for CHEM 1015 Chemistry in Context or CHEM 1016 Chemistry in Context.

Prerequisites

Some courses listed on this checksheet may have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Minimum GPA

For the courses attempted for this minor, the student must have a GPA of 2.0 or better.

For planning purposes, students may wish to be aware that the following courses are typically taught during:

- Fall Semester: STS 2454 Science, Techology, and Environment, STS 3334 Energy and Society, SPIA 2554 Collaborative Policy-Making and Planning, MINE 2114 Energy and Raw Materials: Geopolitics and Sustainable Development, CHEM 1015 Chemistry in Context, FREC 4174 Climate Change and the International Policy Framework, FREC 4464 Water Resources Policy and Economics, ENSC 1015 Foundations of Environmental Science, GEOS 1014 Evolution of the Earth-Life System, and STS 3284 Technology and Disability.
- Spring Semester: CHEM 1016 Chemistry in Context, PHIL 1304 Morality and Justice, STS 2444 Global Science and Technology Policy, SPIA 4464 Data and the Art of Policy-Making and Planning, GEOS 1024 Earth Resources, Society, and Environment, CHEM 3054 Postconsumer Materials, MSE 1014 The Science of Materials in Everyday Life, CHEM 4054 , ENSC 1016 Foundations of Environmental Science, and GEOS 1004 Earth Science: Our Past, Present, and Future.

Mathematics (MATH) Minor

Code	Title	Credits
Required Minor Courses		
MATH 1225	Calculus of a Single Variable (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
MATH 1226	Calculus of a Single Variable (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
or CMDA 2005	Integrated Quantitative Sciences	
MATH 2214	Introduction to Differential Equations (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
or CMDA 2006	Integrated Quantitative Sciences	
Elective Courses [1]		
Select nine credits of MATH courses numbered 3000 or higher. Subject to restrictions and exceptions in the footnote below.		9
Total Credits		**26**

Footnote

[1] **The following courses can also be used as Elective Courses:**

- MATH 2534 Introduction to Discrete Mathematics
- CMDA 3605 Mathematical Modeling: Methods and Tools
- CMDA 3606 Mathematical Modeling: Methods and Tools
- CMDA 4604 Intermediate Topics in Mathematical Modeling

The following courses are cross-listed with MATH courses and therefore can also be used as Elective Courses:

- AOE 4404 Applied Numerical Methods
- AOE 5404 Numerical Methods for Aerospace and Ocean Engineering
- CS 3414 Numerical Methods
- CS 4414 Issues in Scientific Computing

The following course can be used only with approval by the Math Undergraduate Policy & Curriculum Committee. Contact math advising.

- MATH 4984 Course MATH 4984 Not Found

The following courses CANNOT be used as Elective Courses:

- MATH 4044 History of Mathematics
- MATH 4625 Mathematics for Secondary Teachers
- MATH 4626 Mathematics for Secondary Teachers
- MATH 4644 Secondary School Mathematics With Technology
- MATH 4664 Senior Math Education Seminar
- MATH 4754 Internship
- MATH 4974 Independent Study
- MATH 4994 Undergraduate Research

Graduation Requirements

Minimum Credits Required for Graduation

At least 26 credits required.

To graduate with a Virginia Tech undergraduate degree, a minimum of 25% of total credits for majors and minors must be taken at Virginia Tech. This means at least 7 credits for the math minor must be taken at Virginia Tech.

Minimum GPA Required for Graduation

Students are required to have 2.0 in-minor GPA.

Grade Mode

All courses used for the math minor must be taken in A-F grade mode.

Medicine and Society (MSOC) Minor

Code	Title	Credits
Required Minor Courses		
Select one of the following:		3
STS 2154	The Life Sciences and Society	
HIST 3734	History of Modern Biology	
HIST/STS 3705	History of Science	
HIST/STS 3706	History of Science	
ENGL 3154	Literature, Medicine, and Culture	
Select one of the following:		3
STS 3284	Technology and Disability	
STS/WGS 4334	Sexual Medicine	
SOC 4704	Medical Sociology	
SOC 4414	Drugs and Society	
Select one of the following:		3
STS 3314	Medical Dilemmas and Human Experience	
STS 3124	Societal Health in North America	
PHIL 3324	Biomedical Ethics	
GEOG 4074	Medical Geography of Infectious Diseases	
Subtotal		9
Elective Courses		
Select 9 credit hours of the following:		9
ENGL 3534	Literature and the Environment [1]	
ENGL 3154	Literature, Medicine, and Culture	
HD 1004	Childhood and Adolescence	
HD 2004	Adulthood and Aging	
HD 2314	Human Sexuality	
HD 3114	Issues in Aging	
HD 4324	Advanced Family Relationships	
HIST/STS 3705	History of Science (if not taken as requirement)	
HIST/STS 3706	History of Science	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health (if not taken as requirement)	
HIST 3734	History of Modern Biology (if not taken as requirement)	
HUM 3204	Multicultural Communication [1]	
PHIL 1304	Morality and Justice	

PHIL 3314	Ethical Theory [1]	
PHIL 4604	Philosophy of Biology [1]	
PHS 2004	Introduction to Public Health	
PSYC 3054	Health Psychology [1]	
RLCL 1044	Religious Ethics	
SOC 3714	Sociology of Aging (if not taken as requirement) [1]	
SOC 4414	Drugs and Society (if not taken as requirement) [1]	
SOC 4704	Medical Sociology (if not taken as requirement) [1]	
SOC 4714	Sociology of Mental Illness (if not taken as requirement) [1]	
STS 2034	Introduction to Technology and Race	
STS 2154	The Life Sciences and Society	
STS 2724	Introduction to Displacement Studies	
STS 3104	Science and Technology in Modern Society	
STS/APS 3124	Societal Health in North America	
STS 3284	Technology and Disability (if not taken as requirement)	
STS 4304	Contemporary Issues in Science, Technology, and Society	
STS 4334	Sexual Medicine	
STS 4754	Internship (max. 3hrs for the minor credit)	
STS 4994	Undergraduate Research (max. 3hrs for the minor credit)	
WGS/STS 4704	Gender and Science [1]	
Subtotal		9
Total Credits		**18**

Graduation Requirements

The minor in Medicine and Society consists of 18 credit hours distributed as below. A minimum of 12 hours must be at the 3000 or 4000 level.

- A GPA of 2.0 in all courses taken from the minor checksheet is required.
- Courses must be taken for a grade.
- Students will be enrolled as participants when they formally enroll in the minor.

Medieval & Early Modern Studies (MEES) Minor

Code	Title	Credits
Required Minor Courses		
I. The following course:		
RLCL 1214	The Medieval World	3
Subtotal		3
II. Select one course from each of the following groups:		*6*
Art and History		
ART 3284	Medieval Art and Architecture	
ART 3384	Renaissance Art and Architecture	
ART 3484	Baroque and Rococo Art and Architecture	
HIST 3314	The Later Roman Empire	
HIST 3324	The Medieval World	
HIST 3334	The Renaissance World, 1350-1500	
HIST 3344	Early Modern and Reformation History, 1500-1650	
Literature, Languages, and Thought		
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 4124	Introduction to Old English	
GER 3305	Topics in German Culture and Literature	
LAT 2134	Late Medieval Latin	
PHIL 2116	Ancient Through Medieval Philosophy	
PHIL/PSCI 3015	Political Theory	
SPAN 3404	Early Peninsular Culture and Literature	
SPAN 3444	Topics in Early Spanish American Cultures	
SPAN 4304	Topics in Early Modern Literature and Culture	
Subtotal		6
III. Additional Courses		
Select three additional courses (9 credits) from those listed below or from topics courses relevant to Medieval & Early Modern Studies. [1]		9
ART 2385	Survey of the History of Western Art	
ART 3284	Medieval Art and Architecture [2]	
ART 3384	Renaissance Art and Architecture [2]	
ART 3484	Baroque and Rococo Art and Architecture [2]	
ENGL 1634	Introduction to Shakespeare	
ENGL 3204	Medieval Literature [2]	
ENGL 3214	Renaissance Literature [2]	
ENGL 4054	History of the English Language	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English [2]	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
FR 3424	French Culture from Middle Ages to Renaissance	
GER 3305	Topics in German Culture and Literature [2]	
HIST 2345	History of the Middle East	
HIST 3314	The Later Roman Empire [2]	
HIST 3324	The Medieval World [2]	
HIST 3334	The Renaissance World, 1350-1500 [2]	
HIST 3344	Early Modern and Reformation History, 1500-1650 [2]	
HIST 3354	Reform and Revolution in Early Modern England	
HIST 3524		
LAT 2134	Late Medieval Latin [2]	
PHIL 2116	Ancient Through Medieval Philosophy [2]	
PHIL/PSCI 3015	Political Theory [2]	
RLCL 1214	The Medieval World [3]	
RLCL 2324	Islam	
RLCL 3424	Orthodoxy and Heresy in Early Christianity	
RLCL/HIST 3504	The Age of The Crusades	
SPAN 3404	Early Peninsular Culture and Literature [2]	
SPAN 3444	Topics in Early Spanish American Cultures [2]	
SPAN 4304	Topics in Early Modern Literature and Culture [2]	
STS 2715	History of Technology	

STS/HIST 3705	History of Science	
TA 3105	History of Drama and Theatre	
Subtotal		9
Total Credits		**18**

1 Permission to include courses not specifically listed here, however, must be granted by the minor coordinator.
2 Cross-listed in section II, above. Note, however, that these courses will not be counted twice.
3 Cross-listed in section I, above. Note, however, that these courses will not be counted twice.

Graduation Requirements

Special offerings, topics courses, Independent Study (4974), Special Study (4984), or Undergraduate Research (4994) in any department, so long as the topic is appropriate, may also be counted towards this minor.

Permission to include courses not specifically listed here, however, must be granted by the minor coordinator. Please note that all upper division courses may require prerequisites. Students must take responsibility to familiarize themselves with any other prerequisites that may be required when selecting courses. Students must have an over-all GPA of 2.0 and an in-minor GPA of 2.0 in order to graduate. Students interested in the Medieval & Early Modern Studies Minor are encouraged to talk with Prof. Charlene M. Eska, ceska@vt.edu

Meteorology (MTRG) Minor

Code	Title	Credits
Required Minor Courses		
GEOG 1514	Introduction to Meteorology	3
GEOG 1524	Introduction to Earths Climate	3
GEOG 2505	Weather Analysis I	3
GEOG 2506	Weather Analysis II	3
Subtotal		12
Geography/ Meteorology Restricted Electives		
Select 3 of the following:		9
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 2114	Introduction to Coastal Regions	
GEOG 3274	Polar Environments	
GEOG/CSES/GEOS 3304	Geomorphology	
GEOG 3404	Mountain Geography	
GEOG 3504	Severe Weather	
GEOG 4044	Biogeography	
GEOG/GEOS 4134	Interdisciplinary Issues and Ethics in Water Resources	
GEOG 4224	Tracking Environmental Change	
GEOG 4514	Tropical Meteorology	
Subtotal		9
Total Credits		**21**

Graduation Requirements

- Upon declaring the MTRG minor, students who are majoring in Geography may no longer use any of the "Required Courses" above (GEOG 1514, GEOG 1524, GEOG 2505, and GEOG 2506) towards their GEOG major requirements. These courses may apply ONLY toward the MTRG minor.
- A minimum overall GPA of 2.0 in these courses is required to complete the minor.
- All minors must include 6 or more credits at 3000 level or above.
- All courses must be taken for an A-F grade unless they are only offered P/F.

Steps for completing the Meteorology Minor

- Declare minor using a 'Minor Declaration Form' found on the CNRE Advising Center website: www.cnre.vt.edu/advising
- Include minor information when updating the application for degree in Hokie Spa.
- Students cannot graduate until they have either
  a. satisfied the requirements for the minor OR
  b. withdrawn from the minor by notifying CNRE Academic Programs office in 138 Cheatham and revised their DARS.

Middle East Studies (MEST) Minor

Code	Title	Credits
I. Required Minor Courses		
RLCL 2324	Islam	3
HIST 2345	History of the Middle East	3
or HIST 2346	History of the Middle East	
Select one of the following:		3
ARBC 1105	Elementary Arabic	
ARBC 1106	Elementary Arabic	
ARBC 1114	Accelerated Elementary Arabic	
ARBC 2105	Intermediate Arabic	
ARBC 2106	Intermediate Arabic	
ARBC 3105	Advanced Arabic	
ARBC 3106	Advanced Arabic	
ARBC 3474	Topics in Arab Cinema	
ARBC 3514	Media Arabic	
Subtotal		9
II. Elective Courses		
Select three Elective Courses (two of which must be at the 3000 level or above). Only one elective can be a language class. [1]		9
Religion and Culture		
RLCL 1024	Judaism, Christianity, and Islam	
RLCL 1024H		
RLCL/WGS 3014	Women and Gender in Islam	
RLCL/HIST 3504	The Age of The Crusades	
RLCL/IS/ARBC 3644	Religion in the Middle East	
History		
HIST 2345	History of the Middle East [2]	
HIST 2346	History of the Middle East [2]	

HIST 3654	Arab-Israeli Conflict	
Foreign Languages and Literatures		
ARBC 1105	Elementary Arabic [2]	
ARBC 1106	Elementary Arabic [2]	
ARBC 1114	Accelerated Elementary Arabic	
ARBC 2105	Intermediate Arabic [2]	
ARBC 2106	Intermediate Arabic [2]	
ARBC 2774	Arab Culture and Civilization [2]	
ARBC 3105	Advanced Arabic [2]	
ARBC 3106	Advanced Arabic [2]	
ARBC 3304	Modern Arabic Literature in Translation [2]	
ARBC 3474	Topics in Arab Cinema [2]	
ARBC 3514	Media Arabic	
School of Visual Arts		
ART 3054	Islamic Art and Architecture	
Political Science		
JUD/PSCI 3544	The State of Israel: A Political History	
PSCI 3594	Topics in Middle East Politics and International Relations	
Government and International Affairs		
GIA 5314	Middle East Geopolitics	
GIA/PSCI 5614/ HIST 5544	Understanding The Israeli Palestinian Conflict	
Economics		
ECON 3314	Middle East Economics	
Subtotal		9
Total Credits		**18**

[1] ARBC 1105, ARBC 1106, ARBC 1114, ARBC 2105, ARBC 2106, ARBC 3105, and ARBC 3106 count as language classes.

[2] Course offerings listed in both Section I and Section II may not be counted twice.

Graduation Requirements

Special offerings, topics courses, Independent Study (4974), Special Study (2984 or 4984), or Undergraduate Research (4994) in any department, so long as the topic is appropriate, may also be counted towards this minor. Permission to include courses not specifically listed here, however, must be granted by the minor coordinator.

Please note that all upper division courses may require prerequisites. Students must take responsibility to familiarize themselves with any prerequisites that may be required when selecting courses.

Students must have an over-all GPA of 2.0 and an in-minor GPA of 2.0 in order to graduate. According to Policy 11(c) all courses used to fulfill the requirements of the minor will be used to determine the minor GPA.

Students interested in the Middle East Studies Minor are encouraged to talk with Dr. Rachel Scott, rmscott@vt.edu, 540-231-4848.

Music (Jazz Studies) (MMJS) Minor

Code	Title	Credits
I. Music Theory		
Take all three of the following:		6
MUS 2815	Jazz Improvisation	
MUS 2816	Jazz Improvisation	
MUS 3815	Advanced Jazz Improvisation	
Subtotal		6
II. Music History/Literature		
MUS 3814	Jazz History	3
MUS 4974	Independent Study	3
Subtotal		6
III. Practical/Ensemble Experience		
TA/MUS 2604	Introduction to Arts Marketing	3
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
MUS 3314	Instrumental Ensemble Music [1]	1
Subtotal		10
Total Credits		**22**

[1] All semesters of MUS 3314 must be jazz-focused, with at least two semesters of MUS 3314 Instrumental Ensemble Music: Jazz Ensemble (Combos), and at least two semesters of MUS 3314 Instrumental Ensemble Music: Jazz Ensemble (Big Band) or Jazz Ensemble II (Big Band).

Graduation Requirements

A minimum of 6 credit hours must be completed at the 3000 or 4000 academic level.

A minimum minor GPA of 2.0 from all courses taken to fulfill the minor is required.

Music (MUS) Minor

Code	Title	Credits
Music Theory		
Select one of the following:		6
MUS 1005 & MUS 1006	Theory Fundamentals and Theory Fundamentals	
OR		
MUS 2025 & MUS 2026	European-American Music Theory and European-American Music Theory	
Subtotal		6
Music History/Literature		
MUS 2115	Survey of Western Music	3
MUS 2116	Survey of Western Music	3
Subtotal		6
Upper Level (6 credits required)		**6**

Choose one of the following tracks:		
Track A		
MUS 3814	Jazz History	
MUS 3164	History of Electronic Music	
Track B		
MUS 3814	Jazz History	
or MUS 3164	History of Electronic Music	
And		
MUS 3314	Instrumental Ensemble Music (Repeat course three times for a total of three credit hours)	
Or		
MUS 3414	Choral Ensemble Music (Repeat course three times for a total of three credit hours)	
Or		
MUS 2514	Individual Applied Voice [1]	
MUS 2524	Individual Applied Keyboard [1]	
MUS 2534	Individual Applied Violin [1]	
MUS 2544	Individual Applied Viola [1]	
MUS 2554	Individual Applied Cello [1]	
MUS 2564	Individual Applied Bass [1]	
MUS 2574	Individual Applied Flute [1]	
MUS 2584	Individual Applied Oboe [1]	
MUS 2594	Individual Applied Clarinet [1]	
MUS 2614	Individual Applied Saxophone [1]	
MUS 2624	Individual Applied Bassoon [1]	
MUS 2634	Individual Applied Horn [1]	
MUS 2644	Individual Applied Trumpet [1]	
MUS 2654	Individual Applied Trombone [1]	
MUS 2664	Individual Applied Baritone [1]	
MUS 2674	Individual Applied Tuba [1]	
MUS 2684	Individual Applied Percussion [1]	
Subtotal		6
Total Credits		**18**

[1] An audition is required for Individual Applied Lessons, and availability is dependent upon faculty availability in the appropriate studio.

Graduation Requirements

A GPA of 2.0 or higher is required in the Music minor. All courses listed on this check sheet are included in the Minor GPA calculations.

18 credit hours are required for the Music minor.

Music (Technology Emphasis) (MMTX) Minor

Code	Title	Credits
I. Music Theory		
Select two of the following:		6
MUS 1005	Theory Fundamentals	
MUS 1006	Theory Fundamentals	
MUS 2025	European-American Music Theory	
MUS 2026	European-American Music Theory	
Subtotal		6
II. Music History/Literature		
MUS 3814	Jazz History	3
or MUS 3164	History of Electronic Music	
Subtotal		3
III. Technology Core		
MUS 2055	Audio Technology For Music	3
MUS 2056	Audio Technology For Music	3
Subtotal		6
IV. Technology Advanced		
Select one of the following series:		6
Series a.		
MUS 3055	Music and Media Production	
MUS 3056	Music and Media Production	
Series b.		
MUS 3065	Computer Music and Multimedia Design	
MUS 3066	Computer Music and Multimedia Design	
Subtotal		6
Total Credits		**21**

"Some courses listed on this check sheet have prerequisites. Please consult the University Course Catalog or check with your advisor.

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Total Hours Required= 21 credit hours

Nanoscience (NANO) Minor

Code	Title	Credits
Required Minor Courses		
NANO 1015	Introduction to Nanoscience: From Atoms to Applications	3
NANO 1016	Introduction to Nanoscience	3
NANO 2024	Quantum Physics of Nanostructures	4
or PHYS 3324	Modern Physics	
NANO 2114	Nanoscience Research Seminar	1
NANO 3015	Nanoscale Synthesis, Fabrication, and Characterization	4
NANO 3016	Nanoscale Synthesis, Fabrication, and Characterization	4
Total Credits		**19**

Graduation Requirements

Prerequisites

Some courses have a prerequisites. Students are required to double check prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Minimum GPA

For the courses attempted for this minor the student must have a GPA of 2.0 or better.

National Security and Foreign Affairs (NSFA) Minor

Code	Title	Credits
Required Minor Courses		
PSCI 1014	Introduction to United States Government and Politics	3
IS/PSCI/GEOG 2054	Introduction to World Politics	3
Select one of the following:		3
IS 3734	National Security	
IS 3104	Security Studies: Theories and Concepts	
IS 3624	Foreign Policy and Diplomacy	
IS 3625	US-Russia Foreign Policies	
IS 3626	US-Russia Foreign Policies	
IS 3704	National Security Strategy	
IS 3735		
IS 3736		
IS/PSCI 4735	Topics in Multilateral Diplomacy Workshop	
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop	
IS 4024	Seminar in Diplomacy and Security	
Subtotal		9
Elective Courses		
Select 9 credit hours from the approved Minor Elective List [1]		9
Subtotal		9
Total Credits		**18**

[1] At least ***one*** elective must be at the 3000/4000 level. Please note that not all courses are offered each semester. Check in the Undergraduate Course Catalog or with the department offering the course to find out when courses are offered.

Elective Courses for National Security and Foreign Affairs Minor

Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses are offered.

International Studies (IS)

Code	Title	Credits
IS/PSCI 1114	Introduction to Transatlantic Studies	3
IS/GEOG/PSCI 2034	Geography of Global Conflict	3
IS/PSCI/FST 2044	Food, War and Conflict	3
IS/PSCI 2104	Europe Country Analysis	3
IS/PSCI 2114	Transatlantic Political Frameworks	3
IS/PSCI/GEOG 2224	Geography of Europe	3
IS 2474	Religion and Violence	3
IS/PSCI 3004	Professionalism and Careers in Political Science and International Studies	3
IS/GEOG/PSCI 3034	The CIA: Its Capabilities in Todays Geo-Political World	3
IS/PSCI 3054	The Dark Web and Threat Analytics	3
IS/PSCI 3104	Security Studies: Theories and Concepts	3
IS/PSCI 3114	Global Security	3
IS/PSCI 3115	Selected World Problems	3
IS/PSCI 3116	Selected World Problems	3
IS/PSCI 3125	Intelligence and National Security	3
IS/PSCI 3126	Intelligence and National Security	3
IS/PSCI 3134	Global Conflict and War	3
IS/PSCI 3135	Strategies of Modern Warfare	3
IS/PSCI 3136	Strategies of Modern Warfare	3
IS/PSCI 3184	Human Security	3
IS/PSCI 3194	Nuclear Strategy & Politics	3
IS/PSCI 3594	Topics in Middle East Politics and International Relations	3
IS/PSCI 3624	Foreign Policy and Diplomacy	3
IS/PSCI 3625	US-Russia Foreign Policies	3
IS/PSCI 3626	US-Russia Foreign Policies	3
IS/PSCI 3704	National Security Strategy	3
IS/PSCI 3734	National Security	3
IS/PSCI 3735		3
IS/PSCI 3736		3
IS/PSCI 3795	Global Terrorism and Counterterrorism	3
IS/PSCI 3796	Global Terrorism and Counterterrorism	3
IS/PSCI 3804	European Integration	3
IS/PSCI 3814	The European Union: Institutions and Policies	3
IS/PSCI 3824	European Union's Foreign and Security Policy	3
IS/PSCI 3825	European Union's Foreign Relations	3
IS/PSCI 3826	European Union's Foreign Relations	3
IS/PSCI 3834	European Security Governance	3
IS/PSCI/GEOG 3844	European Geopolitics	3
IS/PSCI 3894	Transatlantic Relations Since 1945	3
IS/PSCI 3924	Theories of Transatlantic Relations	3
IS/PSCI 3934	NATO & European Security	3
IS 4004	Seminar in International Studies	3
IS 4014	International Development	3
IS/PSCI 4024	Seminar in Diplomacy and Security	3
IS/PSCI 4034	Topics in Diplomacy Lab	3
IS 4044	International Communication	3
IS/PSCI 4074	The Politics of Cybersecurity	3
IS 4134	Capstone Research Project in European Studies	3
IS/PSCI 4144	Topics in Transatlantic Relations	3
IS/PSCI 4184	Capstone Project Transatlantic Studies	3
IS/PSCI 4734	Theories and Practices of International Conflict Management	3
IS/PSCI 4735	Topics in Multilateral Diplomacy Workshop	3
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop	3
IS/PSCI 4744	Intelligence Analysis Workshop	3

Political Science (PSCI)

Code	Title	Credits
PSCI/GEOG/IS 2034	Geography of Global Conflict	3

PSCI/GEOG/IS 3034	The CIA: Its Capabilities in Todays Geo-Political World	3
PSCI/IS 3115	Selected World Problems	3
PSCI/IS 3116	Selected World Problems	3
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
PSCI 3564	Violent Political Change	3
PSCI/IS 3624	Foreign Policy and Diplomacy	3
PSCI 3634	Human Rights: Global Issues	3
PSCI 3625	US-Russia Foreign Policies	3
PSCI 3626	US-Russia Foreign Policies	3
PSCI/IS 3704	National Security Strategy	3
PSCI/UAP 3714	The U. S. Policy Process	3
PSCI 4614	Senior Seminar in International Relations	3
PSCI/IS 4734	Theories and Practices of International Conflict Management	3
PSCI/IS 4744	Intelligence Analysis Workshop	3

Graduation Requirements

Hours Requirement: A minimum of 18 hours is required to graduate with an National Security and Foreign Affairs (NSFA) minor. A minimum of 6 credit hours must be completed at the 3000 or 4000 academic level (This is a university requirement and is met by the minor requirements).

GPA requirement: GPA of 2.0 is required for the IS minor. All courses listed on this checksheet are included in the National Security and Foreign Affairs minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Dual Use of Courses: Only required courses common across departmental majors and minors can double count.

Intra-departmental majoring and minoring: Due to overlapping of courses, students cannot pursue another major within the Department of Political Science. However, they can pursue any of the minors offered by the department except the Minor in Political Science.

Natural Resources Recreation (NRR) Minor

Code	Title	Credits
Complete a minimum of 18 credit hours, distributed as follows:		
Required Minor Courses		
Complete all courses below (9 credits)		
FREC/NR/LAR 2554	Leadership for Global Sustainability	3
FREC 3524	Environmental Interpretation [1]	3
FREC 3544	Outdoor Recreation Planning and Management [1]	3
Subtotal		9
ENVIRONMENTAL POLICY RESTRICTED ELECTIVE		
Complete 1 course below (3 credits)		3
AAEC 3314	Environmental Law [1]	
or FREC 4434	Natural Resource Policy	
Subtotal		3
RECREATION RESTRICTED ELECTIVES		
Select two of the following:		6
FREC/GEOG/SBIO/FIW 3954	Study Abroad (max 3 credit hours) [2]	
HNFE 2274	Wilderness First Responder	
HTM 2464	Designing the Service Experience	
HTM 3484	Socio-Cultural Impacts of Tourism	
Subtotal		6
Total Credits		**18**

1. Course has additional prerequisites or restrictions. Check course catalog or timetable for further information
2. Study abroad must be pre-approved for use in the minor. A study abroad can only satisfy a maximum of 3 credit hours towards Minor in Natural Resources and Recreation Restricted Electives.

Graduation Requirements

This Minor requires completion of a minimum of 18 credits.

Notes for the Minor in Natural Resource Recreation

1. A minimum average GPA of 2.0 in these courses is required to complete the minor.
2. All courses must be taken for A-F grade unless only offered P/F.
3. Students in the Environmental Conservation & Society Major are not eligible to declare the Natural Resources Recreation Minor.

Steps for Completing the Minor in Natural Resource Recreation

1. Sign up for the minor in the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall).
2. If you have the questions about the checksheet, ask the Advising Center to put you in contact with the departmental advisor or faculty member in natural resource recreation.
3. When you request or update your DARS, be sure to include the minor so that it will check your progress on both your major and minor.
4. Once you have enrolled in the minor, you cannot graduate until you either (i) satisfy the credit requirements for the minor, or (ii) withdraw from the minor by notifying the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall) and revising your DARS.

Naval Engineering (NAVE) Minor

Naval Engineering is defined as a field of study and expertise that includes all engineering and sciences as applied in the research, development, design, construction, operation, maintenance and logistic support of surface and subsurface ships, craft, aircraft, and vehicles (manned and autonomous) used by the Navy for the Nation's defense. It inherently includes multiple engineering disciplines, and hence it is open to all students in the College of Engineering who meet the following requirements.

Code	Title	Credits
Required Minor Courses		
AOE 2204	Introduction to Ocean Engineering	3
AOE 4264	Principles of Naval Engineering	3

AOE 4244	Naval and Marine Engineering Systems Design	3
Select a minimum of 9 additional credits of the following: [1]		9
AOE 4265	Ocean Vehicle Design (with approved NE focus)	
AOE 4266	Ocean Vehicle Design (with approved NE focus)	
XXX 4994	Undergraduate Research w/NE focus	
AOE 3134	Air Vehicle Dynamics	
AOE 3124	Aerospace Structures	
AOE 3154	Astromechanics	
AOE 3164	Aerothermodynamics and Propulsion Systems	
AOE 3224	Ocean Structures	
AOE 3234	Ocean Vehicle Dynamics	
AOE 3264	Thermodynamics and Marine Propulsion	
AOE 4234	Aerospace Propulsion Systems	
CEE 3104	Introduction to Environmental Engineering	
CHE 2164	Chemical Engineering Thermodynamics	
CS 3724	Introduction to Human-Computer Interaction	
CS 3114	Data Structures and Algorithms	
CS 3214	Computer Systems	
CS 3304	Comparative Languages	
ECE 3054	Electrical Theory	
ECE 3304	Introduction to Power Systems	
ECE 4224	Power Electronics	
ECE 3574	Applied Software Design	
ECE 3504	Principles of Computer Architecture	
ESM 2204	Mechanics of Deformable Bodies	
ESM 3054	Mechanical Behavior of Materials	
ESM 4044	Mechanics of Composite Materials	
ESM 4734/ AOE 4024	An Introduction to the Finite Element Method	
ISE 3614	Human Factors Engineering and Ergonomics	
ISE 2014	Engineering Economy	
ISE 2404	Deterministic Operations Research I	
ISE 3414	Probabilistic Operations Research	
ISE 3624	Industrial Ergonomics	
ME 2134	Thermodynamics	
ME 3304	Heat and Mass Transfer	
ME 3414	Fluid Dynamics	
ME 3514	System Dynamics	
ME 4124	Computer Aided Design of Fluid-Thermal Systems	
MSE 4034	Thermodynamics of Materials Systems	
MSE 3054/3064	Mechanical Behavior of Materials	
Total Credits		**18**

[1] Prerequisites may apply -- see your advisor

Graduation Requirements

Naval Engineering is defined as a field of study and expertise that includes all engineering and sciences as applied in the research, development, design, construction, operation, maintenance and logistic support of surface and subsurface ships, craft, aircraft, and vehicles (manned and autonomous) used by the Navy for the Nation's defense. It inherently includes multiple engineering disciplines, and hence it is open to all students in the College of Engineering who meet the following requirements.

To complete the Naval Engineering minor students must:

- complete 18 credit hours as prescribed in the program requirements
- maintain a 2.0 in-minor GPA

Naval Leadership (MN) Minor

Code	Title	Credits
Required Minor Courses		
MN 1004	Introduction to Naval Science	3
PHIL 2304	Global Ethics	3
MN 4005	Leadership and Management/Ethics	3
MN 4006	Leadership and Management/Ethics	3
Subtotal		
Elective Courses		
Select nine credits of the following: [1]		9
HIST 3254	The Vietnam War	
HIST 3484	Nazi Germany: History and Memory	
HIST 3644	Twentieth-Century Russia	
HIST 3524		
HIST 3534	Modern Military History	
HIST 3544	World War II	
PHIL 1304	Morality and Justice	
PHIL 3314	Ethical Theory	
PHIL/MGT 4324	Business and Professional Ethics	
PHIL 4334	Jurisprudence	
LDRS 1414	Citizen Leadership	
LDRS 2014	Principles of Peer Leadership	
LDRS 3104	The Dynamics of Leadership	
LDRS 3304	Elements of Team Leadership	
MN 1104	Naval Ships Systems I: Engineering	
MN 2004	Naval Ships Systems II: Weapons	
MN 2104	Seapower and Maritime Affairs	
MN 3005	Navigation and Naval Operations	
MN 3006	Navigation and Naval Operations (NROTC label: "Naval Operations and Seamanship")	
MN 3204	Evolution of Warfare	
MN 4204	Amphibious Warfare	
MN 4974	Independent Study	
Subtotal		
Total Credits		**21**

[1] At least 3 hours of elective courses must be at the 3000 or 4000 level.

Graduation Requirements

Hours Requirement: A minimum of 21 hours is required to graduate with a Naval Leadership (MN) minor.
GPA Requirement: A GPA of 2.5 is required for the MN minor. All courses listed on this checksheet are included in the MN minor GPA calculation.

Prerequisites: Some courses listed on this checksheet have prerequisites. Consult the University Catalog and/or check with Academic Advisor.
Double-counting: Any student pursuing multiple minor programs may use courses completed for other minor programs towards completion quotas for this minor (provided that the course is listed on this checksheet as a requirement or elective).

Nuclear Engineering (NE) Minor

Code	Title	Credits
Required Minor Courses		
MATH 2214	Introduction to Differential Equations	3
NSEG 3145	Fundamentals of Nuclear Engr (C-) [1]	3
NSEG 3146	Fundamental of Nuclear Engr (C-) [1]	3
NSEG 3604	Radiation Detection, Protection and Shielding (C-) [2,3]	3
or NSEG 5604	Radiation Detect & Shielding	
Subtotal		12
Elective Courses		
Select two of the following:		6
NSEG 4204	Nuclear Fuel Cycle (C-) [2,3]	
or NSEG 5204	Nuclear Fuel Cycle	
NSEG 4214	Nuclear Power Plant Operations (C-) [2,3]	
or NSEG 521	Nuclear Plant Systems & Ops	
NSEG 4424	Reactor Thermal Hydraulics (C-) [2,3]	
or NSEG 5424	Reactor Thermal Hydraulics	
MSE 4384	Nuclear Materials (C-) [2,3]	
or MSE 5384	Advanced Nuclear Materials	
NSEG 4974	Independent Study (C-, 3 hours max)	
NSEG 4994	Undergraduate Research (C-, 3 hours max)	
Subtotal		6
Total Credits		**18**

1. Undergraduates accepted in the accelerated BS/MS program can substitute ME5114, Nuclear Engineering Fundamentals, 3 credits, for the NSEG 3145/3146 sequence but then a third elective course will be required for a total of 18 credit hours.
2. Undergraduate students not already accepted into the accelerated BS/MS program must take the undergraduate version of this course and will not be permitted to enroll in the graduate-level course.
3. Students within 2 semesters of graduating who have a minimum overall GPA of 3.0 or higher who have not been accepted into an accelerated BS/MS program may request permission to enroll in a 5000-level NSEG course provided that: (1) an undergraduate version of the course is not available, (2) the student cannot otherwise complete the minor with current undergraduate course offerings, and (3) the student has earned a B or higher in all previous NSEG courses. Permission from both the ME department head and the course instructor are required for the student to enroll in a 5000-level NSEG course. These courses may not be used on the Plan of Study for a graduate degree at Virginia Tech.

Graduation Requirements

Minor Requirements

1. Complete a minimum of 18 credits of nuclear engineering-related coursework - 12 credits of required courses and 6 credits of elective courses from the attached list.
2. Maintain a 2.0 in-minor GPA and earn a minimum grade of C- or better in all courses which count toward the minor, with the exception of MATH2214, which must receive a passing grade.
3. No pass/fail grades will be permitted.

Organizational Leadership (BOLD) Minor

Code	Title	Credits
Required Minor Courses		
MGT 2354	Teams, Leadership, and Business: Cultivating Excellence (Pathways Concept 3 - Reasoning in the Social Sciences)	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility (Pathways Concept 1 - Discourse 1A and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
Subtotal		6
Elective Courses		
Select two courses from the Electives list. At least one elective must be a Pathways course.		6
Subtotal		6
Required Experiential Activity		
Select one of the following:		3
MGT 3064	Cornerstones of Entrepreneurship and Innovation	
MGT 4084	Management Consulting	
MGT 4964	Field Study	
Subtotal		3
Required Capstone Course		
MGT 4354	Leadership: Advances in Skills and Concepts	3
Subtotal		3
Total Credits		**18**

Elective Courses - choose two, 6 credit hours.

Electives can be chosen as complements to your major to develop skills in Creativity & Innovation, Critical & Strategic Thinking, Holistic Thinking & Ethical Reasoning, and/or Intercultural Communication. At least one elective (3 credits) **must** be a Pathways course.

Code	Title	Credits
Creativity and Innovation Courses		
FA 2004	Creativity and the Artistic Experience (Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A)	3
HIST/SOC/STS 2604	Introduction to Data in Social Context (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 5 - Quantitative and Computational Thinking , 5F)	3
HORT 2164	Floral Design (Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A or 6D)	3

ITDS 1114	Design Appreciation (Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A or 6D)	3
MGT 2204	Global Business of Pop Culture (Pathways Concept 2 - Critical Thinking in the Humanities and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
Critical and Strategic Thinking Courses		
ACIS 1004	Accounting Foundations (Pathways Concept 5 - Quantitative and Computational Thinking , 5F)	3
ART 2385	Survey of the History of Western Art (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A)	3
COMM 2084	Media and Society (Pathways Concept 3 - Reasoning in the Social Sciences)	3
LDRS 3304	Elements of Team Leadership (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PHIL 1504	Critical Thinking (Pathways Concept 5 - Quantitative and Computational Thinking , 5F)	3
PHIL 3505	Modern Logic and Its Development	3
TA/MUS 2604	Introduction to Arts Marketing	3
TA 3604	Arts Management	3
Holistic Thinking & Ethical Reasoning		
CMST 3064	Persuasion	3
GEOG/NR 1115	Seeking Sustainability (Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 3114	(Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
HIST 3554	Age of Globalization (Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences)	3
LDRS 3104	The Dynamics of Leadership	3
MGT 4314	International Management	3
MGT/PHIL 4324	Business and Professional Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)	3
MN 4005	Leadership and Management/Ethics (Pathways Concept 3 - Reasoning in the Social Sciences)	3
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities)	3
Intercultural Communication Courses		
COMM 2004	Public Speaking (Pathways Concept 1 - Discourse , 1A)	3
HUM/RLCL 3204	Multicultural Communication (Pathways Concept 3 - Reasoning in the Social Sciences)	3
MGT 3444	Multicultural Diversity in Organizations (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	3
PR 4074	Organizational Communication	3
TA 2404	Introduction to Applied Collaborative Techniques (Pathways Concept 1 - Discourse , 1A or Pathways Concept 6 - Critique and Practice in Design and the Arts , 6A or 6D)	3

Graduation Requirements

The minor in Organizational Leadership (BOLD) is open to all Virginia Tech students with a GPA of at least 2.50.

Students can apply for the BOLD minor at http://pampl.in/addminor (http://pampl.in/addminor/)

Notes

- Students must complete the minor with at least a 2.0 GPA in the 18 credit hours required by the minor.
- Course substitution requests for the minor can be submitted at https://pamplin.vt.edu/leadership-center/minor/course-substitution.html
- Business majors should not take ACIS 1004 Accounting Foundations as they cannot earn credit for both ACIS 1004 Accounting Foundations and ACIS 2115 Principles of Accounting.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Packaging Systems & Design (PSD) Minor

The minor in Packaging Systems and Design requires the completion of 18 credit hours with at least 6 at the 3000 or 4000 level as follows:

Code	Title	Credits
Required Minor Courses		
SBIO 2004	Computer-Aided Design in Packaging	3
SBIO 2104	Principles of Packaging	3
SBIO 3124	Paper and Paperboard Packaging	3
SBIO 3224	Packaging Distribution Systems	3
Subtotal		12
Elective Courses		
Select two of the following:		6
SBIO 2124	Structure and Properties of Sustainable Biomaterials	
SBIO 3284	Packaging Polymers and Production	
SBIO 4024	Packaging Design for Global Distribution	
SBIO 4214	Food and Health Care Packaging	
SBIO 4224	Industrial Packaging Systems	
Subtotal		6
Total Credits		**18**

All courses must be taken on the letter grade (A/F) option. A minimum GPA of 2.00 is required for all courses taken in the minor.

Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog or check with your advisor.

Pathways to Sustainability (PSUS) Minor

A minimum of 18 credit hours to include:

Code	Title	Credits
Required Minor Courses		
GEOG/NR 1115	Seeking Sustainability	3
GEOG/NR 1116	Seeking Sustainability	3
Subtotal		6
Core Pathways Courses		
Humanities: Pathways Concept 2 - Critical Thinking in the Humanities		
Select one of the following: [1]		3
AAEC 3324	Environment and Sustainable Development Economics	
APS/HUM 1704	Introduction to Appalachian Studies	
ENGL 3534	Literature and the Environment	
FREC 2554	Leadership for Global Sustainability	
HIST 3144	American Environmental History	
MGT 3444	Multicultural Diversity in Organizations	
STS 3334	Energy and Society	
Environment: Pathways Concept 4 - Reasoning in the Natural Sciences		
Select one of the following:		3
ENSC 1015	Foundations of Environmental Science	
FIW 2114	Principles of Fish and Wildlife Conservation	
FREC 2114	Ecology of Appalachian Forests	
FREC/HORT 2134	Plants and Greenspaces in Urban Communities	
GEOS 1024	Earth Resources, Society, and Environment	
Art & Design: Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select one of the following: [2]		3
ART 2385	Survey of the History of Western Art	
GEOG 3314	Cartography	
ITDS 1114	Design Appreciation	
SBIO 2104	Principles of Packaging	
TA 2024	Introduction to Acting	
TA 2404	Introduction to Applied Collaborative Techniques	
Subtotal		9
Required Capstone: Pathways Concept 3 - Reasoning in the Social Sciences		
GEOG/NR 4444	Practicing Sustainability	3
Subtotal		3
Total Credits		**18**

1 Except MGT 3444 Multicultural Diversity in Organizations & AAEC 3324 Environment and Sustainable Development Economics

2 Except SBIO 2104 Principles of Packaging

All minimum overall GPA of 2.0 in these courses is required to complete the minor.

All minors must include 6 or more credits at 3000 level or above.

All courses must be taken for an A-F grade unless they are only offered P/F.

Steps for successful completion of the Pathways to Sustainability Minor:

- Declare minor using a 'Major/Option/Minor Form' found in the CNRE Advising Center, 138 Cheatham Hall.
- Include minor information when updating the application for degree in Hokie Spa.
- Some courses in the minor requirements listed above have prerequisites, so be sure to consult the University Catalog or check with the Minor advisor.
- Students cannot graduate until they have either:
  a. satisfied the requirements for the minor or
  b. withdrawn from the minor by notifying CNRE Academic Programs office in 138 Cheatham and revised their DARS.

Peace Studies and Social Justice (PSSJ) Minor

Code	Title	Credits
Required Introduction		
Pathways Course		
PSVP 2044	Peace and Violence (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness)	3
Subtotal		3
Elective Courses (Must take at least 3 credits at the 3000-/4000-level)		
Select three credits from each of the areas:		12
A. Root Causes of Violence		
Pathways Courses		
GEOS 1034	Earths Natural Hazards (3 hours Pathways Concept 4 - Reasoning in the Natural Sciences and 3 hours Ethical Reasoning)	
HIST 1354	Conflict and Security in Modern East Asia (3 hours of Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness) [1]	
HIST/AFST/IS 3864	(3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness) [1]	
HIST 3114	(3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Ethical Reasoning) [1]	
HIST 3564	The Cold War (3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness) [1]	
PHIL 3314	Ethical Theory (3 hours Pathways Concept 2 - Critical Thinking in the Humanities and 3 hours Ethical Reasoning) [1]	
STS 3334	Energy and Society (3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness) [1]	

WGS 1824	Introduction to Womens and Gender Studies (3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness) [1]
B. Acts of Violence	
Pathways Courses	
CRIM 4474	Cyber Criminology (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Ethical Reasoning)
GEOG 1014	World Regions (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness)
HIST 3544	World War II (3 hours Pathways Concept 2 - Critical Thinking in the Humanities or Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Ethical Reasoning and Intercultural and Global Awareness)
PSCI/GEOG 2054	Introduction to World Politics (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness)
HIST 3054	The American Civil War (3 hours Pathways Concept 1 - Discourse (Advanced/Applied) or Pathways Concept 2 - Critical Thinking in the Humanities and 3 hours Intercultural and Global Awareness)
HIST 3654	Arab-Israeli Conflict (3 hours Pathways Concept 2 - Critical Thinking in the Humanities and 3 hours Intercultural and Global Awareness)
SOC 2004	Social Problems (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Intercultural and Global Awareness)
Non-Pathways Courses	
CRIM 3414	Criminology
CRIM 4424	Juvenile Delinquency
GEOG/IS/PSCI 2034	Geography of Global Conflict
JUD/HIST/RLCL 3494	The Holocaust
PSCI 3564	Violent Political Change
PSVP 4444	Schools, Violence, and Justice
PSVP 4484	Hate Crimes
C. Strategies for Reducing Violence and Promoting Peace	
AAEC 1264	(3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness)
AAEC 3324	Environment and Sustainable Development Economics (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Intercultural and Global Awareness)
BIT/MGT 2404	(3 hours Pathways Concept 5 - Quantitative and Computational Thinking (Foundational) and 3 hours Intercultural and Global Awareness)
HUM/RLCL 3204	Multicultural Communication (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and 3 hours Intercultural and Global Awareness)
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Ethical Reasoning)
PHIL 4334	Jurisprudence (3 hours Pathways Concept 2 - Critical Thinking in the Humanities and 3 hours Ethical Reasoning)
SOC 2034	Diversity and Community Engagement (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Intercultural and Global Awareness)
SOC 3314	Social Movements (3 hours Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Intercultural and Global Awareness)
Non-Pathways Courses	
PSVP 2444	Conflict Resolution, Mediation and Peacebuilding
CRIM 3434	Systems of Justice
SOC 4404	Sociology of Law
D. Data and Information	
Pathways Courses	
ENGL 2634	Writing and Social Justice (3 hours Pathways Concept 1 - Discourse (Advanced/Applied) and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States and 3 hours Ethical Reasoning)
HD 3024	Community Analytics (3 hours Pathways Concept 5 - Quantitative and Computational Thinking (Advanced/Applied) and 3 hours Ethical Reasoning)
HIST/SOC/STS 2604	Introduction to Data in Social Context (3 hours Pathways Concept 5 - Quantitative and Computational Thinking (Foundational) and Pathways Concept 2 - Critical Thinking in the Humanities and 3 hours Ethical Reasoning and Intercultural and Global Awareness)
SOC/HD 2104	Quantitative Approaches to Community Research (3 hours Pathways Concept 5 - Quantitative and Computational Thinking (Foundational) or 3 hours Ethical Reasoning)
Subtotal	12
Required Capstone	
Non-Pathways Course	
PSVP 4104	Global Society, Violence and the Prospects for Peace 3
Subtotal	3
Total Credits	**18**

Graduation Requirements

Minimum GPA of 2.0 or higher is required for the minor.

Some courses on this checksheet may have prerequisites, please consult the Undergraduate Course Catalog.

1 Course must be taken for Critical Thinking in the Humanities credit.

Philosophy (PHIL) Minor

Code	Title	Credits
Required Minor Courses		
PHIL 1504	Critical Thinking	3
or PHIL 3505	Modern Logic and Its Development	
Select 6 hours of Philosophy courses at the 3000 or 4000 level		6
Select one of the following:		3
An additional Philosophy course at the 3000 or 4000 level		
PHIL 2115	Ancient Through Medieval Philosophy	
PHIL 2116	Ancient Through Medieval Philosophy	
PHIL 2125	History of Modern Philosophy	
PHIL 2126	History of Modern Philosophy	
Subtotal		12
Philosophy Elective Courses		
Select 6 hours of electives in Philosophy at any level		6
Subtotal		6
Total Credits		**18**

Code	Title	Credits
Minor and Electives		
PHIL 1204	Knowledge and Reality	3
PHIL 1304	Morality and Justice	3
PHIL 1504	Critical Thinking	3
PHIL 1604	How Science Works	3
PHIL 2115	Ancient Through Medieval Philosophy	3
PHIL 2125	History of Modern Philosophy	3
PHIL 2126	History of Modern Philosophy	3
PHIL 2304	Global Ethics	3
PHIL 2314	Philosophy of Sex, Gender, and Race	3
PHIL 3015	Political Theory	3
PHIL 3016	Political Theory	3
PHIL 3024	Topics in Philosophical Movements	3
PHIL 3314	Ethical Theory	3
PHIL 3324	Biomedical Ethics	3
PHIL 3334	Ethical Perspectives on Artificial Intelligence	3
PHIL 3414	Aesthetics	3
PHIL 3454	Philosophy of Religion	3
PHIL 3506		3
PHIL 3614	Philosophy of the Environment	3
PHIL 4014	Special Topics in Philosophy	3
PHIL 4204	Philosophy of Mind	3
PHIL 4214	Metaphysics	3
PHIL 4224	Epistemology	3
PHIL 4304	Political Philosophy	3
PHIL 4334	Jurisprudence	3
PHIL 4514	Special Topics in Logic	3
PHIL 4604	Philosophy of Biology	3
PHIL 4614	Philosophy of Science	3

Graduation Requirements

A minimum minor GPA of 2.0; According to Policy 11(c) all courses used to fulfill the requirements of the minor will be used to determine the minor GPA.

Philosophy, Politics, and Economics (PPE) Minor

Program Curriculum

Code	Title	Credits
I. Core Areas Elective Courses		
Select one course from each core area from the approved minor list.		
Philosophy [1]		3
Political Science		3
Economics		3
Subtotal		9
II. PPE Gateway Course		
PPE 2894	PPE Gateway Course [1]	3
Subtotal		3
III. Applied Areas Elective Course		
Select one course from the approved minor list		3
Subtotal		3
IV. PPE Capstone Course		
PPE 4884	PPE Capstone Course [1]	3
Subtotal		3
Total Credits		**18**

[1] These courses satisfy the following Pathways General Education core and integrated outcomes:

1. Core Areas Elective Courses, Philosophy - Critical Thinking in Humanities and Ethical Reasoning,
2. PPE 2894 PPE Gateway Course - Reasoning in the Social Sciences and Ethical Reasoning, and
3. PPE 4884 PPE Capstone Course - Advanced Discourse and Intercultural Global Awareness.

Please be aware that depending on major, course(s) completed to satisfy program degree core requirements may limit the use of specific course(s) listed on this minor from being completed to satisfy Pathways requirement(s).

Core Areas Elective Courses

Code	Title	Credits
Core Area 1: Philosophy		
Select one of the following:		
PHIL 1304	Morality and Justice	3
PHIL 2304	Global Ethics	3
PSCI/PHIL/PPE 3016	Political Theory	3
PHIL/PPE 3314	Ethical Theory	3
PHIL/PPE 4304	Political Philosophy	3

PHIL 4324	Business and Professional Ethics	3
PHIL 4334	Jurisprudence	3
PPE/PHIL/PSCI/ ECON 3884	Topics in Philosophy, Politics, and Economics	3
Core Area 2: Political Science		
Select one of the following:		3
PSCI 1014	Introduction to United States Government and Politics	3
or PSCI 1014H	Honors Introduction to United States Government and Politics	
or PSCI 2014	Introduction to Political Theory	
PSCI/PPE 2024	Research Methods in Political Science	3
PSCI/GEOG/IS 2054	Introduction to World Politics	3
PSCI/GEOG/IS 2064	The Global Economy and World Politics	3
PSCI/PHIL/PPE 3016	Political Theory	3
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
PSCI 3554	Comparative Political Economy	3
PSCI 3724	Poverty and Welfare Policy	3
PSCI 3744	Public Policy Analysis	3
PSCI 3764	Contemporary Democratic Theory	3
PSCI/IS 4054	Seminar in Global Political Economy	3
PSCI 4214	Senior Seminar in Political Behavior	3
PSCI 4724	Senior Seminar in Political Theory	3
PPE/PHIL/PSCI/ ECON 3884	Topics in Philosophy, Politics, and Economics	3
Core Area 3: Economics		
Select one of the following:		
AAEC 1005	Economics of the Food and Fiber System (micro)	3
ECON 1104	Economics of Gender	3
ECON 1204	Economics of Race	3
ECON/PPE 1214	Economic History of Diversity and Inclusion	3
ECON 2005	Principles of Economics (microeconomics)	3
ECON 2025H	Honors Principles of Economics (microeconomics)	3
ECON 3004	Contemporary Economic Issues	3
ECON/PPE 3024	Economic Justice	3
ECON 3104	Microeconomic Theory	3
ECON/BDS 3134	Choice and Behavior	3
ECON 3254	Applied Econometrics	3
ECON 4014	Environmental Economics	3
ECON 4044	Public Economics	3
ECON 4074	Labor Economics	3
ECON 4124	Growth and Development	3
ECON/AAEC 4135	International Economics	3
ECON 4214	Economics of Health Care	3
ECON 4424	The Theory of Games and Economic Behavior	3
ECON 4434	Experimental Economics	3
ECON/NEUR/ PSYC 4454	Neuroeconomics	3
ECON 4894	Law and Economics	3
PPE/PHIL/PSCI/ ECON 3884	Topics in Philosophy, Politics, and Economics	3

Applied Areas Elective Courses

Code	Title	Credits
Applied Area 1: Business		
MGT 1104	Foundations of Business	3
MGT 2114	Principles of Project Management	3
MGT/HTM 2314	Introduction to International Business	3
MGT 2504	Sustainable Business Management	3
MGT 2614	Foundations of Management Consulting and Data Analytics	3
MGT 3074	Social Entrepreneurship	3
MKTG 3104	Marketing Management	3
or MKTG 3104H	Marketing Management	
MGT 3304	Management Theory and Leadership Practice	3
MGT 3314		3
MGT 3324	Organization Behavior	3
MGT 3334	Managing Human Resources	3
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution	3
MGT 3404	Principles of Management	3
MGT 3444	Multicultural Diversity in Organizations	3
MKTG 3504	Advertising	3
MGT 3614	Strategy and Competition Analytics	3
MGT 4084	Management Consulting	3
MKTG 4304	Marketing Communications	3
MGT 4314	International Management	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility	3
MKTG 4554	Principles of Professional Selling	3
MKTG 4644	Marketing, Society and the Public Interest	3
MKTG 4704	International Marketing	3
PPE 4964	Field Work/Practicum	3
Applied Area 2: Engineering		
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (2+2 credit hours)	4
ENGR 1814		3
ISE 2404	Deterministic Operations Research I	3
ISE 3004	Industrial Cost Control	3
ENGR 3124	Introduction to Green Engineering	3
ISE 3414	Probabilistic Operations Research	3
ISE 3614	Human Factors Engineering and Ergonomics	3
ISE 3624	Industrial Ergonomics	3
ISE 4004	Theory of Organization	3
ISE 4015	Management Systems Theory, Applications, and Design	3
ENGR 4134	Environmental Life Cycle Assessment	3
ISE 4304	Global Issues in Industrial Management	3
PPE 4964	Field Work/Practicum	3
Applied Area 3: Urban Affairs and Planning		
UAP 1024	Leadership, Service, and Public Problem Solving	3
GEOG/SPIA 2244	Sustainable Urbanization	3

UAP 3014	Urban Policy and Planning	3
UAP/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4264	Environmental Ethics and Policy	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4754	Legal Foundations of Planning	3
PPE 4964	Field Work/Practicum	3
Applied Area 4: Geography		
GEOG 2034	Geography of Global Conflict	3
GEOG/PSCI/IS 2054	Introduction to World Politics	3
GEOG/PSCI/IS 2064	The Global Economy and World Politics	3
GEOG 2134	Geography of the Global Economy	3
GEOG 2214		3
GEOG/SPIA 2244	Sustainable Urbanization	3
GEOG 3104	Environmental Justice, Resources and Development	3
GEOG 3254	Geography of East Asia	3
GEOG 4204	Geography of Resources	3
GEOG 4764	International Development Policy and Planning	3
PPE 4964	Field Work/Practicum	3
Applied Area 5: Agriculture and Applied Economics		
AAEC 1264		3
AAEC 3024	Monetary and Global Issues in Applied Economics	3
AAEC 3204	International Agricultural Development and Trade	3
AAEC 3314	Environmental Law	3
AAEC 3324	Environment and Sustainable Development Economics	3
AAEC/ECON 4135	International Economics	3
AAEC 4314	Environmental Economic Analysis and Management	3
AAEC 4344	Sustainable Development Economics	3
AAEC 4814	Food and Health Economics	3
PPE 4964	Field Work/Practicum	3
Applied Area 6: Fish, Wildlife, Forest, and Environmental Conservation		
FREC 2004	Forest Ecosystems	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FREC 2124	Forests, Society & Climate	3
FREC 2554	Leadership for Global Sustainability	3
FREC 2784	Global Forest Sustainability	3
FIW 3414		3
FREC 4014	Natural Resources Economics	3
FIW 4244	Applied Epidemiology of Fish and Wildlife Diseases	3
FREC 4424	Forest Resources Economics and Management	3
FREC 4434	Natural Resource Policy	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
FREC 4454	Urban and Community Forestry	3
PPE 4964	Field Work/Practicum	3

Graduation Requirements

Additional Requirements and Guidelines

1. Departmental prerequisites and corequisites for all courses must be satisfied. Please consult the University Catalog for the latest statement of these requirements.
2. Students are strongly advised to take one (elective) course in each of the three core areas of the PPE Minor before they take the PPE Gateway Course.
3. The PPE Gateway Course must be taken before the PPE Capstone Course, which is assumed to be the final course for fulfillment of the PPE Minor requirements.
4. At least one (core or applied area) elective course must be taken at the 3000-4000 level.
5. All courses for the PPE Minor must be taken A/F and be completed with a minimum GPA of 2.0.
6. According to Policy 11(c) all courses used to fulfill the requirements of the minor will be used to determine the minor GPA.
7. A minimum of 18 credit hours is required to graduate with a PPE Minor.

Physics (PHYS) Minor

Code	Title	Credits
Required Minor Courses		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
PHYS 3324	Modern Physics	4
Subtotal		12
Select nine credits of the following:		9
PHYS 2504	Math Methods in Physics	
PHYS 3355	Intermediate Mechanics [1]	
PHYS 3405	Intermediate Electricity and Magnetism [2]	
PHYS 3406	Intermediate Electricity and Magnetism [3]	
PHYS 3655	Introduction to Astrophysics	
PHYS 3656	Introduction to Astrophysics	
PHYS 3704	Thermal Physics	
PHYS 4254	Quantum Information Technologies	
PHYS 4514	Introduction to Nuclear Physics	
PHYS 4524	Intro Particle Physics	
PHYS 4554	Introduction to Solid State Physics	
PHYS 4564	Polymer Physics	
PHYS 4574	Nanotechnology	
PHYS 4614	Optics	
PHYS 4654	Modern Cosmology	
PHYS 4664	Astroparticle Physics	
PHYS 4674	Introduction to General Relativity	
PHYS 4714	Introduction to Biophysics	
PHYS 4755	Introduction to Computational Physics	
PHYS 4774	Intro to Physics of Galaxies	
Subtotal		9
Total Credits		**21**

[1] Acceptable Substitution: PHYS 3355 may be substituted with AOE 3154 Astromechanics **or** ESM 3124 Dynamics II- Analytical and 3-D Motion.
[2] Acceptable Substitution: PHYS 3405 may be substituted with ECE 3105 Electromagnetic Fields.
[3] Acceptable Substitution: PHYS 3406 may be substituted with ECE 3106 Electromagnetic Fields.

Graduation Requirements

Minimum Hours and GPA Required for Graduation

The Minor in Physics requires the completion of 21 credit hours. A minimum overall and in-minor GPA of 2.0 is required for graduation. All physics courses attempted are used in the calculation of the in-minor GPA.

Prerequisites and Corequisites

Courses in this minor have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Plant Health Sciences (PHS) Minor

Code	Title	Credits
Entry Level Course		
Select one of the following:		3
ALS/BIOL 2404	Biotechnology in A Global Society	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2234	Environmental Factors in Horticulture	
PPWS 2004	Mysterious Mushrooms, Malicious Molds	
PPWS 2104	Plants, Genes, and People	
FREC 2114	Ecology of Appalachian Forests	
Subtotal		3
Required Minor Courses		**10**
PPWS 4104	Plant Pathology	
ENT 4254	Insect Pest Management	
CSES 4344	Crop Physiology and Ecology	
Subtotal		10
Plant/Plant Pest Course		
Select one of the following:		3
BIOL 3204	Plant Taxonomy	
CSES 4144	Plant Breeding and Genetics	
PPWS 2754	Weeds That Shape Our World	
PPWS/ENT 4264	Pesticide Usage	
PPWS 4604	Biological Invasions	
Subtotal		3
Elective Courses		
Select one of the following: [1]		2-3
CSES 3114	Soils	
or GEOS 3614	Soils	
ENSC/BIOL 4164	Environmental Microbiology	
ENT/BIOL 3014	Insect Biology	
ENT/BIOL 3024	Insect Biology Laboratory	
FREC 4514	Forest and Tree Pest Management	
HORT/BIOL 2304	Plant Biology	
PPWS 4114	Microbial Forensics and Biosecurity	
Subtotal		2-3
Total Credits		**18-19**

[1] Can select course from Elective Course List or can take an additional course from Plant/Plant Pest Course list, but may not repeat a course for credit in both sections

Graduation Requirements

Notes:

- Minimum credits to complete minor = 18
- Minimum GPA requirement of 2.0 for courses taken towards the minor
- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor.

Political Science (PSCI) Minor

Code	Title	Credits
Required Minor Courses		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Select one of the following:		3
PSCI 2014	Introduction to Political Theory	
PSCI 2054	Introduction to World Politics	
PSCI 2064	The Global Economy and World Politics	
Subtotal		9
POLITICAL SCIENCE ELECTIVES		
Select nine credit hours of Political Science electives [1]		9
Subtotal		9
Total Credits		**18**

[1] Limit on Repeatable Courses: No more than six credit hours in the following courses may contribute toward the 18 hours required by the minor: PSCI 4754 Internship Program, PSCI 4994 Undergraduate Research, and PSCI 4974 Independent Study.

Graduation Requirements

- PSCI 1034 Introduction to International Studies and Political Science: may not contribute toward the 18 credit hours required by the minor.
- PSCI 3004 Professionalism and Careers in Political Science and International Studies: may not contribute toward the 18 credit hours required by the minor.

Minimum Hours Requirement: A minimum of 18 hours is required for the minor. A minimum of 6 credit hours must be at the 3000 or 4000 academic level.

GPA: A 2.0 GPA is required for the minor. All courses used to fulfill the requirements of the minor will be used to determine the minor GPA.

Please Note: Students with a major in International Studies may not obtain a minor in Political Science.

Regarding Double Majors and Minors: The Department of Political Science offers majors in:

- Political Science
- International Studies
- International Relations
- National Security and Foreign Affairs, and
- International Public Policy

as well as minors in:

- Political Science
- International Studies
- International Relations
- National Security and Foreign Affairs, and
- International Public Policy.

Courses for the majors and minors overlap significantly. Therefore, students may not pursue multiple majors and/or minors within the department.

Popular Culture (POPC) Minor

The minor in Popular Culture requires the completion of 18 credit hours, including at least 9 hours at the 3000-level or above, as follows. All courses listed are three-credit-hour courses.

Code	Title	Credits
Required Minor Courses		
HUM 1504	Introduction to Popular Culture	3
HUM/RLCL 2504	Introduction to American Studies	3
Subtotal		6
Elective Courses		
Select at least 12 credit hours from the following: [1]		12
AFST 2754	Sports and the Afro-American Experience	
AFST 2774	Black Aesthetics	
APS 2434	The Cultural Politics of Music in Appalachia	
CINE 2054	Introduction to Cinema	
ENGL 1624	Introduction to Detective Fiction	
ENGL 1654	Introduction to Science Fiction and Fantasy	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL/CINE 3544	Literature and Cinema	
HIST 3744	Social History of Film [2]	
HTM 3484	Socio-Cultural Impacts of Tourism	
HUM 3034	Theories of Popular Culture	
RLCL 2124	Religion in American Life	
SOC 4114	The Sociology of Popular Music	
Subtotal		12
Total Credits		**18**

1 At least **two** of which must be the 3000-4000 level.
2 This topics course may be repeated for credit when the topic varies.

The following topics courses may be used when the topic pertains to popular, as approved by the minor coordinator.

Code	Title	Credits
AINS 4004	Topics in American Indian Studies [1]	3
APS/HUM 4414	Issues in Appalachian Studies [1]	3
HUM 4104	Explorations in Advanced Humanities Topics [1]	3
RLCL 4324	Topics in Religion and Culture [1]	3
WGS 3004	Topics in Feminism [1]	3

1 This topics course may be repeated for credit when the topic varies.

Graduation Requirements

Special offerings, including, Independent Study, Undergraduate Research, and Study Abroad, and relevant courses in this or other departments, may be uses to fulfill requirements of up to six (6) credits for the minor. Permission to count such courses must be granted by the minor coordinator. Courses taken to fulfill the requirements of the minor cannot be taken as pass/fail unless that is that is only way the course is taught. Students should check the course catalogue for the latest information on course pre-requisites.

To graduate with a minor in Popular Culture Studies, a student must have an over-all GPA of 2.0 and an in-minor GPA of 2.0 from all of the courses taken from the minor check-sheet.

Students who wish to complete this minor or want more information should consult with minor coordinator, Dr. Nicole Ni, 205 Major Williams Hall, (540) 231-1823, nizhange@vt.edu (satterwhite@vt.edu).

Professional and Technical Writing (PTW) Minor

Code	Title	Credits
The Minor in Professional and Technical Writing requires 18 hours distributed as follows: [1]		
Foundational Courses		
ENGL 2844	Introduction to Professional and Technical Writing	3
ENGL 3844	Writing and Digital Media	3
Subtotal		6
Elective Courses		
Select four of the following: [2]		12
ENGL 3474	Rhetoric for Professional Writers	
ENGL 3804	Technical Editing and Style	
ENGL 3814	Creating User Documentation	
ENGL 3824	Visual Rhetoric and Document Design	
ENGL 3834	Intercultural Issues in Professional Writing	
ENGL 4474	Special Topics in Professional and Technical Writing	
ENGL 4804	Grant Proposals and Reports	
ENGL 4814	Developing Online Content	
ENGL 4824	Science Writing	

ENGL 4964	Field Study (max 3 credit hours) [3]	
JMC 4144	Magazine Writing	
Subtotal		12
Total Credits		**18**

[1] All courses on listed on this checksheet (except ENGL 4964 Field Study) have as a prerequisite ENGL 1106 First-Year Writing or COMM 1016 Communication Skills.
[2] At least one of which (3 hours) must be at the 4000-level.
[3] ENGL 4964 is offered only as a Pass/Fail course. The course may count for the Technical and Scientific Communication Minor when taken Pass/Fail.

Graduation Requirements

1. Students declaring the minor who have already taken ENGL 3764 Technical Writing or ENGL 3774 Business Writing and who do not need that course to fulfill a major requirement may substitute that course for ENGL 2844.
2. To graduate with a Minor in Professional and Technical Writing, students must complete all courses comprising the minor with a GPA of 2.0 or better.
3. Minimum credits to complete minor: 18.

Professional Sales (PRFS) Minor

Code	Title	Credits
Required Minor Courses		
MKTG 3104	Marketing Management	3
MKTG 4054	Sales Technology	3
MKTG 4204	Consumer Behavior	3
MKTG 4454	Sales Force Management	3
MKTG 4554	Principles of Professional Selling	3
MKTG 4774	Advanced Professional Selling	3
Subtotal		18
Elective Courses		
Select one of the following:		3
MKTG 3134	Personal Well-being and Professional Success	
MKTG 3164	Introduction to Digital Marketing Strategy	
MKTG 4114	Introduction to AI in Marketing	
MKTG 4164	Social Media and Content Marketing	
MKTG 4254	Product and Price Management	
MKTG 4264	Analytics for Marketing	
MKTG 4354	Marketing Channels and Logistics	
MKTG 4404	Field Practicum in Marketing (by arrangement only)	
MKTG 4604	Retail Management	
MKTG 4974	Independent Study (by arrangement only; must be sales-focused)	
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries	
CMST 3064	Persuasion	
CMST 3124	Interpersonal Communication	
Subtotal		3
Total Credits		**21**

Graduation Requirements

Students must complete the minor with at least a 2.00 GPA in the **21 credit hours** required for the minor. If these criteria are met, the minor will be noted on the transcript.

Application Eligibility

Application to the minor in Professional Sales is open to all university students, with the exception of Marketing majors, with at least a 2.5 overall GPA at Virginia Tech.

Students can apply for the Professional Sales minor at http://pampl.in/addminor

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Major and Minor Courses

No more than 50% of the graded course credits required for the Minor in Professional Sales may be double-counted by a student also enrolled in a non-marketing business degree.

Property Management (PM) Minor

Code	Title	Credits
Required Minor Courses		
PM 2664	Introduction to Property Management	3
PM 3674	Property Management Operations	3
PM 3684	Sustainable Property Management	3
Subtotal		9
Select at least 9 credit hours of the following:		9
AHRM 2404	Consumer Rights	
CONS 2304	Consumer and Family Finances	
RED 2644	Housing and the Consumer	
PM 2684	Marketing and Leasing Residential Properties	
PM 3634	Managing Affordable and Specialized Housing	
PM 3954	Study Abroad	
RED 4604	Environmental and Sustainability Issues in Housing	
PM 4644	Advanced Property and Asset Management	
RED 4664	Universal Design	
PM 4684	Leasing Commercial Properties	
PM 4964	Field Work/Practicum	
PM 4744	Housing Challenges and Policies in the United States (*)	
Subtotal		9
Total Credits		**18**

* RELC majors must take PM 4744 for their 21 credit hour restricted electives requirement.

Graduation Requirements

Students majoring in Residential Environments and Design must select at least 9 credits from the electives list that are not required for the Residential Environments and Design major.

UAP 2004 Principles of Real Estate is an additional elective option for RED students only.

6 hours must be completed at the 3000 level or above.

The minimum GPA for the minor is 2.0.

A minimum of 18 hours is required to graduate with a Property Management minor.

Psychology (PSYC) Minor

Code	Title	Credits
Introductory Requirements		
PSYC 1004	Introductory Psychology	3
PSYC 1094	Principles of Psychological Research [1]	3
Subtotal		6
Foundations of Psychology		
Select one of the following:		3
PSYC 2034	Developmental Psychology	
PSYC 2044	Psychology of Learning	
PSYC 2064	Introduction to Neuroscience of Behavior	
PSYC 2084	Social Psychology	
Subtotal		3
1000-2000-Level Psychology Electives		
Select one of the following:		3
PSYC/ENGL 1524	Language and the Mind	
PSYC 2014	Psychology of Social Interventions	
PSYC 2034	Developmental Psychology	
PSYC 2044	Psychology of Learning	
PSYC 2054	Psychology of Personality	
PSYC 2064	Introduction to Neuroscience of Behavior	
PSYC 2074	Animal Behavior	
PSYC 2084	Social Psychology	
PSYC 2974	Independent Study	
PSYC 2994	Undergraduate Research	
Subtotal		3
3000-4000-Level Psychology Electives [1]		
Select two of the following: [2]		6
PSYC 3014	Psychopathology	
PSYC 3024	Human Behaviors and Natural Environments	
PSYC 3034	Psychological Disorders of Children	
PSYC 3054	Health Psychology	
PSYC 3094	Advanced Research Methods in Psychological Science	
PSYC/EDEP 3154		
PSYC 4014	History and Systems in Psychology	
PSYC 4024	Industrial and Organizational Psychology	
PSYC 4034	Special Topics in Developmental Psychology	
PSYC 4044	Advanced Learning	
PSYC 4054	Personality Research	
PSYC 4064	Physiological Psychology	
PSYC 4074	Sensation and Perception	
PSYC 4084	Advanced Social Psychology	
PSYC 4094	Theory of Psychological Measurement	
PSYC 4114	Cognitive Psychology	
PSYC 4134	Language Development	
PSYC 4154	Bilingual Development and Cognition	
PSYC 4184	The Science of Giving	
PSYC/BDS 4194	Predicting Social Behavior	
PSYC/ECON/ NEUR 4454	Neuroeconomics	
PSYC 4974	Independent Study	
PSYC 4994	Undergraduate Research	
Subtotal		6
Total Credits		**18**

[1] Acceptable substitutions:
- PSYC 1094 Principles of Psychological Research: HD 3014 Research Methods in Human Development or SOC 3204 Social Research Methods
- 3000-4000-Level Psychology Electives Category: HNFE 4644 Health Counseling

[2] Almost all of these courses have prerequisites. Please consult the Course Timetable and Course Catalog.

Graduation Requirements

Total 18 credit hours

A minimum GPA of 2.0 in all courses taken for the minor is required.

Public Health (PH) Minor

Code	Title	Credits
Required Minor Courses		
PHS 2004	Introduction to Public Health	3
HNFE 2664	Behavioral Theory in Health Promotion	3
ADV 2134	Introduction to Health Communication	3
HNFE 3634	Epidemiologic Concepts of Health and Disease	3
PHS 4014	Public Health Program Planning and Evaluation (Junior Standing)	3
PHS 4044	Public Health Policy and Administration (Junior Standing)	3
Total Credits		**18**

Graduation Requirements

18 credit hours required to complete minor

A minimum GPA of 2.0 in all courses taken to fulfill the minor is required

Some courses listed have prerequisite requirements, please consult the University Course Catalog.

Quantum Information Science and Engineering Minor

The Minor in Quantum Information Science and Engineering requires a minimum of 20 credit hours.

Code	Title	Credits
I. Required Minor Courses		**12**
MATH 2114	Introduction to Linear Algebra [1,2]	
or MATH 3144	Linear Algebra I	
PHYS 2254	Hello Quantum World!	
CHEM/PHYS 3684	Quantum Software I [1]	
CHEM/PHYS 4684	Quantum Software II [1]	
PHYS 4254	Quantum Information Technologies [1]	
Subtotal		12
Other Courses		**3**
II. Select one of the following:		
PHYS 4264	Quantum Optics and Qubit Processors [1,3]	
or CS 4134	Quantum Computation and Information Processing	
Subtotal		3
III. Select at least 3 credit hours of the following:		3
PHYS 3314	Intermediate Laboratory [1]	
PHYS 3324	Modern Physics [1]	
PHYS 3406	Intermediate Electricity and Magnetism [1]	
MATH 3034	Introduction to Proofs [1]	
MATH 3144	Linear Algebra I [1,2]	
CS 1064	Introduction to Programming in Python	
CS 2064	Intermediate Programming in Python [1]	
CS 2114	Software Design and Data Structures [1]	
CS 3114	Data Structures and Algorithms [1]	
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization [1]	
CHEM 3616	Physical Chemistry [1]	
ECE 2024	Circuits and Devices [1]	
ECE 2214	Physical Electronics [1]	
ECE 2514	Computational Engineering [1]	
ECE 2714	Signals and Systems [1]	
ECE 3105	Electromagnetic Fields [1]	
ECE 3134	Introduction to Optoelectronics [1]	
ECE 3214	Semiconductor Device Fundamentals [1]	
ECE 3604	Introduction to RF and Microwave Engineering [1]	
ECE 3614	Introduction to Communication Systems [1]	
ECE 3714	Introduction to Control Systems [1]	
MSE 2054	Fundamentals of Materials Science [1]	
MSE 3204	Fundamentals of Electronic Materials [1]	
Subtotal		3
IV. Select at least 2 credit hours of the following:		2
PHYS 4264	Quantum Optics and Qubit Processors [1,3]	
PHYS 4315	Modern Experimental Physics [1]	
PHYS 4455	Introduction to Quantum Mechanics [1]	
PHYS 4456	Introduction to Quantum Mechanics [1]	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 5455	Quantum Mechanics [1]	
CHEM 4404	Physical Inorganic Chemistry [1]	
MATH 4175	Cryptography [1]	
MATH 4176	Cryptography [1]	
MATH 4445	Introduction to Numerical Analysis [1]	
CS/MATH 4414	Issues in Scientific Computing [1]	
CS 4104	Data and Algorithm Analysis [1]	
CS 4134	Quantum Computation and Information Processing [1,3]	
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning [1]	
CS/STAT 5525	Data Analytics [1]	
CS/STAT 5526	Statistical Learning [1]	
ECE 4104	Microwave and RF Engineering [1]	
ECE 4134	Photonics [1]	
ECE 4424/CS 4824	Machine Learning	
ECE 4634	Digital Communications [1]	
ECE 5634	Information Theory [1]	
MSE/ECE 4234	Semiconductor Processing [1]	
Subtotal		2
Total Credits		**20**

1. These courses have prerequisites or corequisites. Students are required to double check course prerequisites and corequisites. Please see your advisor or consult the Undergraduate Course Catalog for more information.
2. This course can only count once. If taken in set I (Required courses), it cannot be counted as an elective from set III.
3. This course can only count once. If taken in set II, it cannot be counted as an elective from set IV.

Graduation Requirements

Credit hours

The Minor in Quantum Information Science and Engineering requires a minimum of 20 credit hours.

Minimum GPA

Must have a 2.0 or higher for all courses used to complete this minor.

Real Estate (REAL) Minor

Code	Title	Credits
A. Required Minor Courses		
ECON 2005	Principles of Economics	3
REAL 1014	Careers in Real Estate	1
REAL/UAP 2004	Principles of Real Estate	3
REAL 2034	Real Estate Data Analysis [1]	3
REAL 3044	Financing Real Estate Projects	3
REAL 4754	Real Estate Law	3
Subtotal		16

B. Additional Courses		
ACIS 2115	Principles of Accounting	3
PM 3674	Property Management Operations	3
or PM 4684	Leasing Commercial Properties	
REAL 3034	Real Estate Market Analysis	3
or MKTG 4734	Real Estate Marketing	
SPIA/GEOG 2244	Sustainable Urbanization	3
or SPIA 4454	Future of Cities	
Subtotal		12
Total Credits		**28**

[1] BIT 2405 Introduction to Business Statistics, Analytics, and Modeling is an approved substitute for REAL 2034 for all Pamplin majors minoring in Real Estate.

Graduation Requirements

Including all pre-requisites, students need a MINIMUM of 2 academic years or 4 semesters to complete the Real Estate minor. Total Credits Required: 28

Real Estate Minor

The Real Estate minor is open to students in all colleges of the University and draws its courses from several departments and colleges within the University. Advisement for the minor will be conducted by an Academic Advisor for the Blackwood Department of Real Estate. For more information, visit www.realestate.vt.edu (http://www.realestate.vt.edu/) or e-mail REALadvisor@vt.edu.

Admission Requirements

Any student (including first-year and transfer) is eligible to apply for the Real Estate minor. Students pursuing the BS Real Estate or BSBUF, Finance and Real Estate major are not eligible to pursue the Real Estate minor.

Students can apply for the Real Estate minor at http://pampl.in/addminor

Satisfactory Progress

The student must maintain a GPA of at least 2.5 for all courses in the minor.

Student Responsibility

Including all pre-requisites, students need a minimum of 2 academic years or 4 semesters to complete the Real Estate minor. It is the responsibility of the student to plan their courses and no course waivers will be processed. The only force adds that will be processed are for juniors, admitted to the minor, who require REAL 1014 Careers in Real Estate as a pre-requisite to register for upper-level courses in the minor.

Pre-requisites

Some courses listed on this checksheet have pre-requisites; please consult the Virginia Tech Undergraduate Catalog or check with your academic advisor for the current pre-requisite requirements.

Certification

In addition to fulfilling the requirements of their individual majors, students must complete the 28 credit hours listed with at least a grade of C- or higher REQUIRED courses and maintain a GPA of at least 2.5 for all courses in the minor. If these criteria are met, the minor will be noted on the student's transcript.

Questions

For additional information, contact an Academic Advisor for the Department of Real Estate: REALAdvisor@vt.edu.

Religion (REL) Minor

Code	Title	Credits
1000-Level or Above		
Select 6 credits (2 courses) of the following or of the lists below:		6
RLCL 1004	Introduction to Religion and Culture	
RLCL 1014	World Religions	
RLCL 1024	Judaism, Christianity, and Islam	
RLCL 1034	Religion and the Modern World	
RLCL 1044	Religious Ethics	
RLCL 1904	Religion and Culture In Asia [1]	
Subtotal		6
2000-Level or Above		
Select 6 credits (2 courses) of the following or of the list below:		6
RLCL 2004	Case Studies in Religion and Culture	
RLCL/SOC 2054	Ethnography: Studying Culture	
RLCL/GR 2104	Greek New Testament	
RLCL 2124	Religion in American Life	
RLCL/JUD 2134	Judaism: A Survey of History, Culture, and Heritage [1]	
RLCL/AFST 2144	African Religions [1]	
RLCL/WGS/ AFST 2204	Race and Gender in Religion and Culture [1]	
RLCL 2324	Islam [1]	
RLCL/JUD 2414	Hebrew Bible/Old Testament	
RLCL 2424	New Testament	
RLCL/CLA/ ENGL 2444	Greek and Roman Myth	
RLCL/STS 2464	Religion and Science	
RLCL/IS 2474	Religion and Violence	
RLCL 2484	Religion and Politics	
Subtotal		6
3000- or 4000 Level		
Select 6 credits (2 courses) of the following:		6
RLCL/WGS 3014	Women and Gender in Islam [1]	
RLCL/ENGL 3024	Religion and Literature	
RLCL 3214	Religion and Culture in India [1]	
RLCL 3224	Religion and Culture in China and Japan [1]	
RLCL/JUD 3404	Torah and Tradition	
RLCL 3414	Jesus in Earliest Christianity	
RLCL 3424	Orthodoxy and Heresy in Early Christianity	

RLCL/JUD/ HIST 3494	The Holocaust	
RLCL/HIST 3504	The Age of The Crusades	
RLCL/JUD/ PSCI 3544	The State of Israel: A Political History	
RLCL/IS/ARBC 3644	Religion in the Middle East	
RLCL 4014	Religion and the Public Sphere	
RLCL/SOC 4024	Sociology of Religion	
RLCL 4324	Topics in Religion and Culture	
Subtotal		6
Total Credits		**18**

[1] At least 3 credits (one course) must be from RLCL courses marked with a [1] in the lists above.

Graduation Requirements

Graduation Requirements: The minor in Religion requires the completion of 18 credit hours (6 courses) from the above lists. To graduate with a minor in Religion, a student must have an over-all GPA of 2.0 and an in-minor GPA of 2.0 from all of the courses taken from the minor check-sheet

For more information, contact the minor coordinator, Dr. Shaily Patel, at 231-8456, or shailyp@vt.edu.

Residential Environments (RENV) Minor

Code	Title	Credits
Required Minor Courses		
RED 1604	Introduction to Residential Design	3
RED 2644	Housing and the Consumer	3
RED 3644	American Housing	3
RED 4604	Environmental and Sustainability Issues in Housing	3
Select two of the following (minimum of 6 credits):		6
RED 2614	Residential Construction	
RED 4224	Historic Preservation of Residential Properties	
RED 4664	Universal Design	
CONS 2304	Consumer and Family Finances	
AHRM 2404	Consumer Rights	
PM 2664	Introduction to Property Management	
PM 3634	Managing Affordable and Specialized Housing	
PM 4744	Housing Challenges and Policies in the United States	
RED 4964	Field Work/Practicum (Housing focus only, max 3 credit hours)	
RED 3954	Study Abroad (max 3 credit hours)	
SBIO 3324	Green Building Systems	
Total Credits		**18**

Graduation Requirements

Minor in Residential Environments not available to students majoring in Property Management.

A minimum of 18 hours is required to graduate with a Residential Environments minor.

An overall GPA of 2.0 or higher must be attained in the courses counting toward the minor.

Russian (RUS) Minor

Code	Title	Credits
Required Minor Courses		
RUS 2105	Intermediate Russian	3
RUS 2106	Intermediate Russian	3
or RUS 2114	Accelerated Intermediate Russian	
RUS 3105	Grammar, Composition and Conversation	3
RUS 3106	Grammar, Composition and Conversation	3
RUS 4204	Topics in Russian Culture and Civilization	3
or RUS 4304	Studies in Russian Literature	
Select one of the following courses taught in English:		3
RUS 2734	Introduction to Russian Culture and Civilization	
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation	
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation	
RUS/ENGL 3424	Topics in Russian Literature in English	
RUS 3434	The Works of Vladimir Nabokov	
Total Credits		**18**

Graduation Requirements

Total Hours Required: 18 credits

Notes: A minimum grade of "C" must be earned in each course completed for the Russian minor. A minimum in-minor GPA of 2.0 is required. All courses used to complete the minor will count toward GPA.

- Courses used to fulfill minor requirements may not be taken Pass/ Fail.
- A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the Chair of the Department, and the Director of the Office of Global Education before the student departs on a study abroad program.
- Some courses in the minor requirements listed above have prerequisites, so be sure to consult the University Catalog or check with your advisor.

Russian Area Studies (RAS) Minor

Code	Title	Credits
Required Minor Courses		
1. Russian History		
HIST 3604	Russia to Peter the Great	3
HIST 3614	Imperial Russia	3
HIST 3644	Twentieth-Century Russia	3

Subtotal		9
2. Russian Politics		
Select one of the following:		3
PSCI 3524	Politics of Post-Communist Systems	
PSCI/IS 3626	US-Russia Foreign Policies	
PSCI/GIA 5424	Communist and Post-communist Systems	
Subtotal		3
3. Russian Literature and Culture		
Select one of the following:		3
RUS 2734	Introduction to Russian Culture and Civilization	
RUS/ENGL 3424	Topics in Russian Literature in English	
HIST 3684		
Subtotal		3
4. Capstone Research Project		
HIST 4994	Undergraduate Research	3
or PSCI 4994	Undergraduate Research	
or RUS 4994	Undergraduate Research	
Subtotal		3
Total Credits		**18**

Graduation Requirements

Minimum of 18 semester hours to complete minor, including a capstone research project submitted to the coordinator of minor upon completion.

Capstone research projects include but are not limited to: 20-page thesis, video or audio documentary, web site or other digital project. A public presentation or publication of the capstone research is recommended. Projects should use Russian sources whenever possible.

Required GPA: 2.0. All courses taken from the list of approved Russian studies courses count in the computation of the minor GPA.

Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog or check with your advisor.

Science, Technology & Law (STL) Minor

Code	Title	Credits
Required Minor Courses		
STL 2304	Foundations of Science, Technology and Law (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Ethical Reasoning) [1]	
STL 4304	Intellectual Property Law	
STL 4314	Current Topics in Science, Technology and Law (Pathways Concept 1 - Discourse (advanced/ applied); Integrative outcome: Ethical Reasoning) [1]	
Subtotal		9
Ethics Course		
Select one of the following:		
STL 4324	Global Aspects of Intellectual Property Law (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Intercultural and Global Awareness) [1]	
PHIL 1304	Morality and Justice (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Ethical Reasoning) [1]	
PHIL 2304	Global Ethics (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Ethical Reasoning) [1]	
Subtotal		3
Civic Course		
Select one of the following:		
PSCI 1014	Introduction to United States Government and Politics (Pathways Concept 3 - Reasoning in the Social Sciences ; Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States; Integrative Outcome: Intercultural and Global Awareness) [1]	
PSCI 1024	Comp Gov & Politics (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]	
PSCI/GEOG/IS 2054	Introduction to World Politics (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]	
PSCI/GEOG/IS 2064	The Global Economy and World Politics (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]	
Subtotal		3
Elective Courses		
Select one of the following:		
STL 4324	Global Aspects of Intellectual Property Law (Pathways Concept 2 - Critical Thinking in the Humanities ; Integrative Outcome: Intercultural and Global Awareness) [1]	
STL 4334	Patent Preparation and Prosecution	
CEE 3104	Introduction to Environmental Engineering	
CEE 4804	Professional and Legal Issues in Civil Engineering (Pathways Concept 1 - Discourse (advanced/ applied), Integrative Outcome: Ethical Reasoning) [1]	
MSE 1004	Materials In Todays World	
AAEC 3604	Agricultural Law	
AAEC 3314	Environmental Law	
UAP 3354	Introduction to Environmental Policy and Planning	
PSCI/IS/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	
UAP 4344	Law of Critical Environmental Areas	
UAP 4754	Legal Foundations of Planning	
HIST 3705	History of Science	
HIST 3706	History of Science	
PSCI 3334	Judicial Process	
STS 1504	Introduction to Science, Technology, and Society (Pathways Concept 2 - Critical Thinking in the Humanities and Pathways Concept 3 - Reasoning in the Social Sciences ; Integrative Outcome: Intercultural and Global Awareness) [1]	
STS 2154	The Life Sciences and Society	

STS 3104	Science and Technology in Modern Society (Pathways Concept 2 - Critical Thinking in the Humanities; Integrative Outcome: Ethical Reasoning)	
PHIL 4614	Philosophy of Science	
PHIL 4604	Philosophy of Biology	
COMM 4024	Communication Law	
Subtotal		3
Total Credits		**18**

Graduation Requirements

A total of 18 hours required.

To complete the minor in Science, Technology & Law, a student must take the three STL core courses (total of 9 credit hours), choose 1 "Ethics" course and 1 "Civic" course (total of 6 credit hours), and take a minimum of 3 credit hours of elective courses. The total amount of credit hours required to complete this minor is 18 credit hours. Students must maintain a minimum 2.0 in-minor GPA. All courses listed count towards in-minor GPA. Some courses listed on this checksheet have prerequisites, please consult the University Course Catalog, or check with your advisor.

Science, Technology & Society (STSO) Minor

Code	Title	Credits
Required Minor Courses		
STS 1504	Introduction to Science, Technology, and Society	3
STS 3504		3
or STS 4304	Contemporary Issues in Science, Technology, and Society	
Subtotal		6
STS Elective Courses		
Select two of the following:		6
STS 2154	The Life Sciences and Society	
STS 2254	Innovation in Context	
STS 2444	Global Science and Technology Policy	
STS 2454	Science, Techology, and Environment	
STS 3104	Science and Technology in Modern Society	
STS 3284	Technology and Disability	
STS 3314	Medical Dilemmas and Human Experience	
STS 3334	Energy and Society	
STS 3504	(if not taken as requirement)	
STS 4304	Contemporary Issues in Science, Technology, and Society (if not taken as requirement)	
STS/HIST 2054	Engineering Cultures	
STS/RLCL 2464	Religion and Science	
STS/HIST/ SOC 2604	Introduction to Data in Social Context	
STS/HIST 2715/ STS 2716	History of Technology	
STS/HIST 3705/ STS 3706	History of Science	
STS/HIST 3734	History of Modern Biology	
STS/WGS 4704	Gender and Science	
STS 2974	Independent Study	
STS 4754	Internship	
STS 4964	Field Study	
STS 4974	Independent Study	
STS 4994	Undergraduate Research	
Subtotal		6
Elective Courses		
Select two of the following:		6
ALS 2204	Sustainable Food Systems (Select two of the following:)	6
ALS/BIOL 2404	Biotechnology in A Global Society	
CMST 3274/ BIOL 2404	Social Dimensions of Games, Simulations, and Virtual Environments	
ENGE 2094	Create!: Ideation & Innovation	
ENGL 3534	Literature and the Environment	
ENGL 3764	Technical Writing	
ENGL 3844	Writing and Digital Media	
ENGL 4824	Science Writing	
GEOG/NR 1115	Seeking Sustainability	
GEOG/NR 1116	Seeking Sustainability	
GEOG 1084/ FREC 1004	Digital Planet	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 4074	Medical Geography of Infectious Diseases	
HIST 3144	American Environmental History	
HIST 3624	Health and Illness in African History	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health	
IS/PSCI 3194	Nuclear Strategy & Politics	
IS/PSCI 4074	The Politics of Cybersecurity	
JMC 4344	Free Speech in Cyberspace	
PHIL 2605 & PHIL 2606	Reason and Revolution in Science and Reason and Revolution in Science	
PHIL 3334	Ethical Perspectives on Artificial Intelligence	
PHIL 4604	Philosophy of Biology	
PHIL 4614	Philosophy of Science	
PSCI/IS 3044	The Politics of Internet Governance	
PSCI 3054/ IS 3044	The Dark Web and Threat Analytics	
SPIA 2554	Collaborative Policy-Making and Planning	
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	
SPIA 4374	Federal Cybersecurity Policy and Regulation	

STL 2304	Foundations of Science, Technology and Law	
STL 4304	Intellectual Property Law	
UAP 3224	Policy Implementation	
UAP/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4264	Environmental Ethics and Policy	
WGS/GEOG/ UAP 4214	Gender, Environment, and International Development	
Subtotal		12
Total Credits		**24**

Graduation Requirements

The minor in Science, Technology, and Society consists of 18 credit hours. A minimum of 9 hours must be at the 3000 or 4000 level. No more than 3 hours total may be Independent Study; no more than 3 hours may be Internship. A minimum GPA of 2.0 in all courses taken to fulfill the minor is required. No more than 50% of the graded course credits required for Minor: Science, Technology, and Society may be double-counted in a student's major.

Smart and Sustainable Cities (SSC) Minor

Code	Title	Credits
SPIA 2004	Introduction to Urban Analytics	3
GEOG/SPIA 2244	Sustainable Urbanization	3
SPIA 2554	Collaborative Policy-Making and Planning	3
UAP 3024	Urban and Regional Analysis	3
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	3
SPIA 4454	Future of Cities	3
Total Credits		**18**

Graduation Requirements

In-minor GPA: Students must have a 2.0 or above in-minor GPA to complete the SSC minor. All courses listed below are used in the computation of the in-minor GPA.

Intra-SPIA Program majoring and minoring: No more than 50% of the graded course credits required for the Minor in Smart and Sustainable Cities may be double-counted by a student also enrolling in a major under the Bachelor of Arts in Public and Urban Affairs.

Prerequisite Statement: Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor.

Sociology (SOC) Minor

Any student enrolled at Virginia Tech can minor in sociology.

Courses taken to fulfill the requirements of the sociology minor also can be used to fulfill the requirements of the Pathways to General Education Curriculum.

Courses taken to fulfill the requirements of the minor cannot be taken pass-fail. Courses with a letter grade of "F" do not count toward the minor requirements.

Sociology courses taken prior to declaring a minor in sociology can count toward meeting the requirements of the minor, including no more than 6 hours of transfer credits in sociology.

GPA Requirement: A minimum of 2.0 GPA in all sociology courses that are taken to fulfill the requirements of the sociology minor. All courses taken to fulfill the requirements of the sociology minor are considered in the calculation of the minor GPA.

Declaring a Sociology Minor

Obtain a Minor Checksheet from the Department of Sociology main office, 560 McBryde Hall.

Complete a **request to change major/minor form** and give it to the staff in the sociology office.

In order to have your minor in sociology processed for the Registrar's records, it is recommended that you submit this form no later than the semester **before** your last semester when you will be graduating. It is not necessary that you complete the 18 hours required for the minor before you submit the form; however, the earlier you submit the form the easier it will be for your advisor to check your DARS form and confirm that the minor requirements have been met. Graduating seniors should refer to the timetable for the last date that the form can be submitted prior to graduation.

Minor Advisor: Meeting with the sociology advisor is not required but highly recommended. Contact the Sociology Department, 560 McBryde, 540-231-8971.

Code	Title	Credits
Required Minor Courses		
SOC 1004	Introductory Sociology	3
Subtotal		3
Sociology Elective Courses		
Select 15 hours of the following:		
1000-2000 SOC courses. None required. No more than 6 hours.		
3000-4000 SOC courses. Minimum of 9 hours.		
Subtotal		15
Total Credits		**18**

Graduation Requirements

Number of Credits in Sociology Required for the Minor: 18 hours

No more than 50% of credits taken toward the minor can double count toward a declared major.

Courses taken to fulfill the requirements of the sociology minor can also be used to fulfill the requirements of the Pathways to General Education Curriculum.

Courses taken to fulfill the requirements of the minor cannot be taken pass-fail. Courses with a letter grade of "F" do not count toward the minor requirements.

Sociology courses taken prior to declaring a minor in sociology can count toward meeting the requirements of the minor, including no more than 6 hours of transfer credits in sociology.

GPA Requirement: A minimum GPA of 2.0 in all sociology courses that are taken to fulfill the requirements of the sociology minor. All courses taken to fulfill the requirements of the sociology minor are considered in the calculation of the minor GPA.

Spanish (SPAN) Minor

Code	Title	Credits
Required Minor Courses		
At least 12 hours of the 18 hours required for the minor must be at the 3000 level or above.		
SPAN 2105	Intermediate Spanish [1]	3
SPAN 2106	Intermediate Spanish [1]	3
or SPAN 2114	Accelerated Intermediate Spanish	
SPAN 3105	Grammar, Composition and Conversation [1,2]	3
SPAN 3106	Grammar, Composition and Conversation [1,2]	3
SPAN 3304	Introduction to Hispanic Literature [2]	3
Subtotal		15
Select one of the following:		3
SPAN 3404	Early Peninsular Culture and Literature [2]	
SPAN 3414	Topics in Modern Cultures of Spain [2]	
SPAN 3444	Topics in Early Spanish American Cultures [2]	
SPAN 3464	Topics in Modern Mexican and Central American Cultures [2]	
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures [2]	
SPAN 3484	Topics in Modern Andean and Southern Cone Cultures [2]	
SPAN 3494	Introduction to Hispanic Linguistics [2]	
SPAN 3514	Spanish for Medical Professions [2]	
SPAN 3524	Introduction to Spanish Translation	
SPAN 3534	Spanish for Business Professions [2]	
SPAN 3544	Sounds of Spanish [2]	
SPAN 3554	Teaching Spanish	
SPAN 3564	Community through Service: Latino NRV [2]	
SPAN 3574	Spanish for Legal Professions	
Subtotal		3
Total Credits		**18**

1. Students who place out of SPAN 2105, SPAN 2106, SPAN 3105 and/or SPAN 3106 should take other Spanish courses at the 3000 or 4000 level to satisfy those credit requirements.
2. Courses may count toward Pathways, depending on students' enrollment date at Virginia Tech.

Graduation Requirements

Students must earn 18 SPAN credits regardless of initial course placement. If you have AP or IB Spanish credit, see your Spanish Advisor.

Additional Information

- A minimum grade of "C" must be earned in each course completed for the Spanish minor. A minimum in-minor GPA of 2.0 is required. Only courses listed on this checksheet or approved substitutions are to be included in the Spanish minor GPA. Courses for the major, minor, or Curriculum for Liberal Education cannot be taken Pass/Fail (exception: SPAN 3125 & SPAN 3126).
- AP exam credit or IB diploma credit may possibly be used to satisfy certain requirements for the minor; please see your Spanish Advisor as soon as possible to make these substitutions.
- Priority is given to Spanish majors and minors for registration in Spanish courses.

Transfer Credit

- Students may transfer no more than 18 of the last 45 cr. of coursework. Study Abroad credits fall under this rule if they are not VT-sponsored study abroad programs.
- At least 25% of the 120 hours required for the degree and 25% of the 18 hours required for the minor must be completed at VT. For a Spanish minor, that is at least 5 credits (2 classes, essentially).
- A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the student's Spanish Advisor, and the Director of the Office of Education Abroad before the student departs on the study abroad program.
- A maximum of 50% of the required credits for a degree program may be earned at a two-year college.

Statistics (STAT) Minor

Code	Title	Credits
Required Minor Courses		
Section I. Statistics Sequence		
Complete one statistics sequence by selecting one course from both Ia and Ib:		6
a. First Course:		
STAT 3005	Statistical Methods	
STAT 3615	Biological Statistics [1]	
STAT 4705	Probability and Statistics for Engineers	
CMDA 2005	Integrated Quantitative Sciences [2]	
b. Second Course:		
STAT 3006	Statistical Methods	
STAT 3616	Biological Statistics	
STAT 4706	Probability and Statistics for Engineers	
CMDA 2006	Integrated Quantitative Sciences [2]	
Subtotal		6
Section II.		
Select one of the following:		3
STAT 4204	Experimental Designs [3]	
STAT 4214	Methods of Regression Analysis [3]	
Subtotal		3
Section III.		
Select at least four of the following:		12
STAT/CMDA 3274	Introduction to Sports Analytics Research	
STAT 3504	Nonparametric Statistics	
STAT/CMDA/ CS 3654	Introductory Data Analytics and Visualization	
STAT 4004	Methods of Statistical Computing	
STAT 4204	Experimental Designs	
STAT 4214	Methods of Regression Analysis	

STAT/CMDA 4274	Sports Analytics Statistical Research	
STAT 4364	Introduction to Statistical Genomics	
STAT 4444	Applied Bayesian Statistics	
STAT 4504	Applied Multivariate Analysis	
STAT 4514	Introduction to Categorical Data Analysis	
STAT 4524	Sample Survey Methods	
STAT 4534	Applied Statistical Time Series Analysis	
STAT/CMDA/CS 4654	Intermediate Data Analytics and Machine Learning	
STAT/CMDA 4664	Computational Intensive Stochastic Modleing	
STAT 4744	Deep Learning	
STAT/AAEC 4804	Elementary Econometrics [4]	
ISE 4404	Statistical Quality Control	
MATH 4454	Applied Mathematical Modeling	
Subtotal		12
Total Credits		**21**

1 If a student completed STAT 3604 prior to becoming a minor, it may replace STAT 3615.
2 If CMDA 2005-CMDA 2006 is chosen, the total hours to complete the minor will increase to 27.
3 If STAT 4204 or STAT 4214 is taken to complete section II, it cannot also satisfy section III.
4 For students completing a major or minor in Economics. ECON 4304 Introduction to Economic Methods can be substituted for STAT 4804.

Graduation Requirements

Prerequisites and Course Duplications:

Some courses listed on this checksheet may have prerequisites: please consult the Undergraduate Course Catalog or check with your advisor for more information. Students are also required to check the duplicate course list.

Course Substitutions and Comments:

1. If a student completed STAT 3604 prior to becoming a minor, it may replace STAT 3615. Also, note prerequisite courses for Section III.

2. For students completing a major or minor in Economics. ECON 4304 Introduction to Econometric Methods can be substituted for STAT 4804.

Satisfactory Progress

A minor GPA of 2.0 or higher must be attained in the courses, counting toward the minor.

Strategic Communications (SCOM) Minor

This minor exposes students to core Pathways learning outcomes and knowledge about how strategic communication works in multiple non-communication industries such as business, sciences, and engineering. Some courses listed on this checksheet have prerequisites. Please consult the University Course Catalog, or check with your adviser.

Code	Title	Credits
I. Foundational Pathways Courses		
COMM 1016	Communication Skills (Pathways Concept 1 - Discourse ; Integrated Outcome: Ethical Reasoning) [1]	3
or COMM 2004	Public Speaking	
PR 2044	Principles of Public Relations (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrated Outcome: Ethical Reasoning) [1]	3
AHRM 1014	Design and Art for Consumers (Pathways Concept 6 - Critique and Practice in Design and the Arts ; Integrated Outcome: Intercultural and Global Awareness) [1]	3
ACIS 1004	Accounting Foundations (Pathways Concept 5 - Quantitative and Computational Thinking ; Integrated Outcome: Ethical Reasoning) [1, 2]	3
Subtotal		12
II. Upper-Level Elective Courses		
Select one of the following:		3
CMST 3064	Persuasion	
CMST 3134	Public Advocacy	
CMST 3214	Professional Communication	
COMM 4024	Communication Law	
FIN 4014	Cyberlaw and Policy (Pathways Concept 3 - Reasoning in the Social Sciences ; Integrated Outcome: Ethical Reasoning) [1]	
HTM 3424	Event Management (Pathways Concept 6 - Critique and Practice in Design and the Arts (design); Integrated Outcome: Ethical Reasoning) [1]	
MGT 3444	Multicultural Diversity in Organizations (Pathways Concept 3 - Reasoning in the Social Sciences and Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States ; Integrated Outcome: Intercultural and Global Awareness) [1]	
MN 4005	Leadership and Management/Ethics (Core Concept 3 Reasoning in the Social Sciences; Integrated Outcome: Intercultural and Global Awareness) [1]	
PR 3014	Public Relations Cases	
PR 3324	Corporate Communication	
PR 3334	Public Relations and Corporate Social Responsibility	
PR 4164	Public Relations Administration	
PR 4364	Crisis Communication and Issue Management	
Subtotal		3
III. Communication Capstone		
PR 4404	Strategic Communication Capstone [3]	3
Subtotal		3
Total Credits		**18**

1 Pathways General Education Course. If you are completing this minor to satisfy Pathways General Education requirements, please reference the core and/or integrated outcome(s) satisfied by each course when you select courses.
2 ACIS 2115 Principles of Accounting may be substituted for ACIS 1004 Accounting Foundations. ACIS 2115 Principles of Accounting is not approved to satisfy Pathways General Education requirements.

[3] Required of all minors.

Graduation Requirements

Minimum credits to Complete the minor: 18

GPA Requirement: A GPA of 2.0 or higher is required in the minor. The GPA is based on all courses a student has completed in the strategic communication minor.

Minor Requirement: All minors must take at least 6 hours of 3000 or 4000 coursework

Sustainable Biomaterials (SBIO) Minor

Minimum credit hours required for completion of minor is 18 with at least nine (9) at the 3000 or 4000 level as follows:

Code	Title	Credits
Required Minor Courses		
SBIO 1234	Introduction to Wood, Design and Craftmanship	3
SBIO 2124	Structure and Properties of Sustainable Biomaterials	3
Subtotal		6
Elective Courses		
Select 12 credit hours of the following: [1]		12
SBIO 2614	Introduction to Forest Products Marketing	
SBIO 2784	Global Forest Sustainability	
SBIO 3004	Sustainable Nature-Based Enterprises	
SBIO 3314	Mechanics of Sustainable Biomaterials and Packaging	
SBIO 3324	Green Building Systems	
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	
SBIO 3444	Sustainable Biomaterials and Bioenergy	
SBIO 3454	Society, Sustainability Biomaterials and Energy	
SBIO 3464	Sustainable Operations Management	
SBIO 3524	Manufacture of Sustainable Biomaterials for Structures	
SBIO 3554	Sustainable Biomaterials Enterprises	
SBIO 4314	Design of Wood Structures	
SBIO 4444	Plant Polymers & Biocomposites	
SBIO 4714	Performance of Sustainable Biomaterials in Buildings	
Subtotal		12
Total Credits		**18**

[1] At least nine credit hours at the 3000 or 4000 level.

All courses must be taken on the letter grade (A/F) option and a minimum GPA of 2.0 is required for all courses taken in the minor. Some courses required for this minor have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisite requirements.

Systems Biology (SYSB) Minor

Code	Title	Credits
Requried Minor Courses		
SYSB 2024	Fundamentals of Systems Biology	3
SYSB 2034	Mathematical Methods in Systems Biology	3
or MATH 2214	Introduction to Differential Equations	
SYSB 3035	Genomics and Bioinformatics	4
SYSB 3115	Network Dynamics and Cell Physiology	4
Subtotal		14
Elective Courses		
Select four credits from the list of courses below:		4
SYSB 3036	Genomics and Bioinformatics	
or CS 3824	Introduction to Computational Biology and Bioinformatics	
or CMDA 3654	Introductory Data Analytics and Visualization	
or STAT 4364	Introduction to Statistical Genomics	
SYSB 3116	Network Dynamics and Cell Physiology	
or CS 4214	Simulation and Modeling	
or CMDA 46(	Intermediate Topics in Mathematical Modeling	
or CMDA 46(	Computational Intensive Stochastic Modeling	
SYSB 4114	Applied Models of Gene Regulatory Networks	
SYSB 4224	Big Data Analysis Methods in Systems Biology (Choose at least four credits from the following list of electives)	
Subtotal		4
Total Credits		**18**

Graduation Requirements

Prerequisites

Some courses listed on these program requirements have prerequisites, please consult the University Course Catalog or check with your advisor

Total credit hours

A total of required hours is 18 credit hours.

Minimum GPA

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Teaching and Learning in Agriculture (TLAG) Minor

The minor for Teaching and Learning in Agriculture will capture the interest of individuals interested in learning how to apply practical educational pedagogy in diverse career settings across all areas of agriculture and life sciences. Completion of the minor will offer students job market opportunities beyond these specifically associated with their major.

The minor in Teaching and Learning in Agriculture requires the completion of 18 credits; 12 credits required courses and 6 credit free

electives from the list below. All courses must be taken and passed on an A - F basis unless only offered on P/F basis.

Code	Title	Credits
Required Minor Courses		
ALCE 3004	Educational Programs in Agricultural and Life Sciences	3
ALCE/EDCT 4034	Methods of Planning Education Programs for Agriculture [1]	3
ALCE 4244	Teaching and Training Methods in Agricultural and Life Sciences	3
ALCE/EDCT 4884	Youth Program Management	3
Subtotal		12
Students will select two courses from either the Agricultural Education Applied Area or the Community Education Applied Area.		**6**
Agricultural Education Applied Area Restricted Electives		
ALCE/AINS 2414	Identity and Inclusion in Agricultural and Life Sciences [3]	
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations	
ALCE 3084	Agricultural Metal Fabrication	
ALCE 4014	Introduction to Cooperative Extension	
ALCE 4024	Managing Agricultural Supervised Occupational Experience Project	
ALCE 4064	Ag Mechanical Lab Management	
ALCE 4234	Curriculum for Career and Occupational Education [2]	
Community Education Applied Area Restricted Electives		
ALCE/AINS 2414	Identity and Inclusion in Agricultural and Life Sciences [3]	
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations	
ALCE 4014	Introduction to Cooperative Extension	
ALCE 4304	Community Education and Development	
ALCE 4234	Curriculum for Career and Occupational Education [2]	
LDRS 4514	Skills for Nonprofit Organizational Leaders	
Total Credits		**18**

1 Prerequisite: ALCE 3004 Educational Programs in Agricultural and Life Sciences
2 Asynchronous online
3 Prerequisite: ENGL 1106 First-Year Writing

Graduation Requirements

- Minimum credits to complete minor - 18
- Minimum GPA requirement - 2.0

Technology, Humans, and Environment (THE) Minor

Code	Title	Credits
Required Minor Courses		
ENGE 2094	Create!: Ideation & Innovation [1]	3
PHIL 3334	Ethical Perspectives on Artificial Intelligence	3
AAD 4234	Capstone Collaborations: Cross-Disciplinary Teams	3
Subtotal		9
Elective Courses		
Technology		
Select one of the following:		3
FREC 1004/ GEOG 1084	Digital Planet	
ITDS 3114	Sustainable Design and Biophilia	
FREC/LAR/NR 2554	Leadership for Global Sustainability	
MSE 1014	The Science of Materials in Everyday Life	
STS 2454	Science, Techology, and Environment	
Humans		
Select one of the following:		3
GEOS 1024	Earth Resources, Society, and Environment	
STS 3284	Technology and Disability	
STS 3334	Energy and Society	
Enviroment		
Select one of the following:		3
ENGR 3124	Introduction to Green Engineering	
ITDS 3114	Sustainable Design and Biophilia	
LAR 3264	People Community and Place	
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development	
SPIA 2554	Collaborative Policy-Making and Planning	
STS 2254	Innovation in Context	
Subtotal		9
Total Credits		**18**

1 It is preferred that students take CREATE! Ideation & Innovation early in the completion of the minor.

Graduation Requirements

All courses for the Technology, Humans, & Environment minor must be taken A/F and be completed with a minimum in-minor GPA of 2.0. Any course taken to fulfill the Technology, Humans, & Environment minor will count toward the minor GPA.

No more than 50% of the graded course credits required for the minor in Technology, Humans, and Environment (THE) may be doubled-counted in a student's major.

Theatre Arts (TA) Minor

A minimum of 18 credit hours are required to complete the Theatre Arts minor. Choose from the list provided here. Of the 18 hours required, a minimum 6 hours must be at the 3000 and/or 4000 level.

Below is a list of the courses that may be applied to the Theatre Arts minor:

Code	Title	Credits
TA 2014	Introduction to Theatre	3
TA 2024	Introduction to Acting	3

TA/AFST/ENGL 2044	Contemporary African American Theatre	3
CINE 2054	Introduction to Cinema	3
TA 2104	Fundamentals of Theatre and Production	3
TA 2114	Script Analysis	3
TA 2204	Creative Dance	3
TA 2404	Introduction to Applied Collaborative Techniques	3
TA 2414	Stage and Lighting Technology	3
TA 2604	Introduction to Arts Marketing	3
TA 2964	Field Study (variable credit)	1-19
TA 2974	Independent Study (variable credit)	1-19
TA 3014	Theatre Production Lab (9 credits max.; some topics are variable credit) [1]	1-3
TA 3024	Intermediate Acting for Non-Theatre Major	3
TA 3105	History of Drama and Theatre	3
TA 3106	History of Drama and Theatre	3
ENGL/TA 3315	Playwriting (consent of instructor required)	3
TA 3604	Arts Management	3
TA 3624	Stage Management	3
TA 3954	Study Abroad (variable credit)	1-19
TA 4304	Theatre Outreach (variable credit, consent of instructor required)	1-3

[1] Topics may include: Scene Shop, Costume Shop, Production Run Crew, Management, Stage Management, Cinema Production Crew, General

The following courses can be applied toward the minor, but they generally are restricted to majors. Instructor permission is required for students in the minor to enroll in these courses.

Code	Title	Credits
TA 2164	Scene Design Lab	3
TA 2174	Costume Design Lab	3
TA 2144	Foundations of Movement and Voice	3
TA 2224	Intermediate Performance Intensive	3
TA 3104	Sound Technology Topics (variable credit)	3-6
TA 3114	Scenography Topics (variable credit)	9
TA 3124	Costume Design and Technology Topics (variable credit)	1-9
TA 3134	Lighting Topics (variable credit)	1-9
TA 3144	Theatre Technology Topics (variable credit)	9
TA 3154	Acting Topics (variable credit)	9
TA 3164	Voice and Speech Topics (variable credit)	9
TA 3174	Movement Topics (variable credit)	9
TA 4014	Contemporary Theatre Seminar	3
TA 4315	Directing	3
TA 4316	Directing	3
TA 4704	Professional Theatre Internship (variable credit/ 9 min, 15 max)	9-15
TA 4964	Field Study (variable credit)	1-19
TA 4974	Independent Study (variable credit)	1-19
TA 4994	Undergraduate Research (variable credit)	1-19

Note: No CINE courses, with the exception of CINE 2054 Introduction to Cinema, may be applied to the Theatre Arts minor.

Graduation Requirements

Of the 18 hours required, a minimum of 6 hours must be in the 3000 and/or 4000 level courses.

A minimum minor GPA of 2.0 in all courses taken to fulfill the minor is required.

Transatlantic Studies (TRST) Minor

Code	Title	Credits
Required Minor Courses		
IS/PSCI 1114	Introduction to Transatlantic Studies	3
Subtotal		3
Elective Courses [1]		
Select nine (9) credit hours of the following:		9
IS/PSCI 2114	Transatlantic Political Frameworks	
IS/PSCI 3894	Transatlantic Relations Since 1945	
IS/PSCI 3924	Theories of Transatlantic Relations	
IS/PSCI 3934	NATO & European Security	
IS/PSCI 4144	Topics in Transatlantic Relations [2]	
IS/PSCI 4154	Topics in Transatlantic Studies [2]	
IS/PSCI 4184	Capstone Project Transatlantic Studies	
Select six (6) hours of the following:		6
International Studies (IS)		
IS/PSCI 2114	Transatlantic Political Frameworks	
IS/PSCI 3804	European Integration	
IS/PSCI 3834	European Security Governance	
IS/PSCI 3854	European Political Economy	
IS/PSCI 3894	Transatlantic Relations Since 1945	
IS/PSCI 3924	Theories of Transatlantic Relations	
IS/PSCI 3934	NATO & European Security	
IS 3944	International Enrollment [3]	
IS 3944S	International Enroll Special 3 [3]	
IS 3944T	International Enroll Special 4 [3]	
IS 3954	Study Abroad (var) [3]	
IS/PSCI 4144	Topics in Transatlantic Relations [2]	
IS/PSCI 4154	Topics in Transatlantic Studies [2]	
IS/PSCI 4184	Capstone Project Transatlantic Studies	
IS/PSCI 4735	Topics in Multilateral Diplomacy Workshop [3]	
IS/PSCI 4736	Topics in Multilateral Diplomacy Workshop [3]	
IS 4964	Field Study (var) [3]	
IS 4994	Undergraduate Research (var) [3]	
Africana Studies (AFST)		
AFST/HIST 2275	African-American History	
AFST/HIST 2276	African-American History	
American Indian Studies (AINS)		
AINS/HIST 3174	Native American History	
French (FR)		

	FR 3206	
	FR 3314	Introduction to Francophone Studies
	FR 3434	French Culture from Baroque to Revolution
German (GER)		
	GER 2724	Introduction to German Culture and Civilization
History (HIST)		
	HIST 1026	Introduction to European History
	HIST 1224	Mesoamerica and the Andes
	HIST/AFST 2275	African-American History
	HIST/AFST 2276	African-American History
	HIST 3004	Colonial America
	HIST 3014	The American Revolution
	HIST/AINS 3174	Native American History
	HIST 3374	French Empire
	HIST 3394	
	HIST 3544	World War II
	HIST 3564	The Cold War
Political Science (PSCI)		
	PSCI/IS 2114	Transatlantic Political Frameworks
	PSCI/IS 3804	European Integration
	PSCI/IS 3834	European Security Governance
	PSCI/IS 3854	European Political Economy
	PSCI/IS 3894	Transatlantic Relations Since 1945
	PSCI/IS 3924	Theories of Transatlantic Relations
	PSCI/IS 3934	NATO & European Security
	PSCI/IS 4144	Topics in Transatlantic Relations [2]
	PSCI/IS 4154	Topics in Transatlantic Studies [2]
	PSCI/IS 4184	Capstone Project Transatlantic Studies
	PSCI/IS 4735	Topics in Multilateral Diplomacy Workshop [3]
	PSCI/IS 4736	Topics in Multilateral Diplomacy Workshop [3]
	PSCI 4964	Field Study (var) [3]
	PSCI 4994	Undergraduate Research (var) [3]
Spanish (SPAN)		
	SPAN 2754	Topics in Spanish American Culture [2]
	SPAN 2764	Introduction to Latino American Studies
	SPAN 3304	Introduction to Hispanic Literature
	SPAN 3444	Topics in Early Spanish American Cultures
	SPAN 3464	Topics in Modern Mexican and Central American Cultures
	SPAN 3474	Topics in Modern Hispanic Caribbean Cultures
	SPAN 3484	Topics in Modern Andean and Southern Cone Cultures
	SPAN 4334	Special Topics in Hispanic Life, Literature, and Language [2]
	SPAN 4344	Hispanic Literature and the Representation of History
Subtotal		15
Total Credits		**18**

[1] At least twelve (12) credit hours at the 3000 level and above.

[2] Topics courses (marked with two asterisks) can be taken up to three times (9 credit hours).

[3] To count for the Minor in Transatlantic Studies the location or the content/topic of all experiential learning courses should be European in character. Those courses will be evaluated and approved by the International Studies Program advisor.

Graduation Requirements

Hours Requirement: A minimum of eighteen (18) credit hours is required to graduate with a Minor in Transatlantic Studies (TRST).

In major GPA: GPA of 2.0 is required for the minor. All courses listed on this checksheet are included in the minor GPA calculation.

Prerequisites: Some courses listed on this checksheet may have pre-/corequisites; please consult the University Catalog or check with your advisor.

Use of Courses: No more than 50% of the graded course credits required for the Minor in Transatlantic Studies (TRST) may be double-counted in a student's Major.

Turfgrass Management (TRFM) Minor Program Curriculum

Code	Title	Credits
Required Minor Courses		
Complete the following 9 credits:		
CSES 2564	Turfgrass Management	
CSES 3564	Golf and Sports Turf Management	
Select one of the following:		
CSES 3114/ GEOS 3614	Soils	
Or		
ENSC 3134	Soils in the Landscape	
Subtotal		9
Restricted Electives		
Select a minimum of 9 credits from the following courses:		
CSES 2224	Foundations of Precision Agriculture	
CSES 4214	Soil Fertility and Management	
CSES 4224	Applied Concepts in Precision Agriculture	
ENSC 3604	Fundamentals of Environmental Science	
ENSC 3644	Plant Materials for Environmental Restoration	
ENT 4254	Insect Pest Management	
ENT 4264	Pesticide Usage	
HORT 3325	Woody Landscape Plants	
HORT 3326	Woody Landscape Plants	
HORT 3664	Hardscape Materials and Installation	
HORT 4205	Public Gardens Maintenance and Management	
HORT 4206	Public Gardens Maintenance and Management	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
HORT 4504	Landscape Contracting	
HORT 4545	Small Scale and Residential Landscape Design	
HORT 4546	Small Scale and Residential Landscape Design	

PPWS 4104	Plant Pathology	
Subtotal		9
Total Credits		**18**

Graduation Requirements

Notes:

- Minimum credits to complete minor = 18
- Minimum GPA requirement of 2.0 for courses taken towards the minor
- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor

Urban and Community Forestry (UACF) Minor

Code	Title	Credits
Complete a minimum of 19 credits from the courses listed below.		
Required Minor Courses		
Select one of the following:		2-3
BIOL/HORT 2304	Plant Biology [1]	
or FREC 2314	Forest Biology and Dendrology	
Select one of the following:		1-3
FREC 2324	Dendrology Laboratory	
or HORT 3324	Woody Landscape Plants	
or HORT 3324	Woody Landscape Plants	
Select one of the following:		1
FREC 2254	Arboriculture Field Skills	
or FREC 3454	Trees in the Built Environment Lab	
Complete the following:		
FREC/HORT 3354	Trees in the Built Environment [1]	3
FREC 4454	Urban and Community Forestry [1]	3
Subtotal		10-13
Restricted Electives		**9**
If FREC 2314 or 2324 taken above, choose 9 credits below; otherwise, choose 6 credits below:		
FREC 2004	Forest Ecosystems	
FREC/HORT 2134	Plants and Greenspaces in Urban Communities	
FREC 3314	Forest Ecology and Silvics [1]	
FREC 3364	Environmental Silviculture [1]	
FREC 4114	Information Technologies for Natural Resource Management [1]	
FREC 4514	Forest and Tree Pest Management [1]	
GEOG 2084	Principles of Geographic Information Systems	
GEOG/SPIA 2244	Sustainable Urbanization	
GEOG 2314	Maps and Mapping	
GEOG 3244	The U.S. City	
LAR 1254	Environment and Natural Systems [1]	
LAR 2254	Social and Cultural Landscapes	
LAR 4034	Evolution of the American Landscape	
PSCI 1014	Introduction to United States Government and Politics	
PSCI 3424	State and Local Government [1]	
PSCI 3434	Urban Politics [1]	
UAP 3014	Urban Policy and Planning [1]	
UAP 4374	Land Use and Environment: Planning and Policy [1]	
Total Credits		**19-22**

[1] Course may have prerequisites or restrictions. Please check the course catalog or timetable for further information.

Graduation Requirements

NOTES FOR THE MINOR IN URBAN AND COMMUNITY FORESTRY

This Minor requires completion of a minimum of 19 credit hours.

1. A minimum of 6 credit hours must be completed at the 3000 or 4000 academic level.
2. A minimum GPA of 2.0 in courses comprising the minor ls required to complete the minor.
3. All courses must be taken for A-F grade unless only offered P/F.
4. Some listed courses have prerequisites or restrictions. These prerequisites and restrictions are determined by the department offering a course and may change without notice. Therefore, we recommend you consult the University Course Catalog and your advisor when planning classes.

COMPLETING THE MINOR IN URBAN AND COMMUNITY FORESTRY

1. Sign up for the minor in the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall).
2. If you have questions about the checksheet, ask the Advising Center to put you in contact with a faculty member In urban and community forestry.
3. When you request or update your DARS, be sure to Include the minor so that It will check your progress on both your major and minor.
4. Once you have enrolled in the minor, you cannot graduate until you either (I) satisfy the credit requirements for the minor, or (ii) withdraw from the minor by notifying the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall) and revising your DARS.

[1] Course has prerequisites or restrictions. Check course catalog or timetable for further information.

[2] If FREC 2314 Forest Biology and Dendrology or FREC 2324 Dendrology Laboratory taken in **Required Minor Courses**, choose 9 credits; otherwise, choose 6 credits.

Visual Arts and Society (VAS) Minor

Code	Title	Credits
Required Minor Courses (6 credits)		
ART 1104	Language of Visual Arts	3
Select one of the following:		
ART 2385	Survey of the History of Western Art	3
or ART 2386	Survey of the History of Western Art	
Practice-Based Art Courses (3 credits)		
Select one of the following:		3

ART 1004	Topics in Studio Art for Non-Majors	
ART 1204	Principles of 2D Art and Design	
ART 1214	Principles of 3D Art and Design	
ART 1234	Topics in Visual Communication Design for Non-Majors	
ART 1404	Principles of Drawing	
ART 1504	Contemporary Art and Practice	
ART 1604	Principles of 4D Art & Design	
Subtotal		9
Electives (6 credits; minimum 3 credits must be at the 3000-level or higher)		
Select two of the following:		6
AFST 1714	Introduction to African American Studies	
WGS 1824	Introduction to Womens and Gender Studies	
PSYC 1004	Introductory Psychology	
SOC 1004	Introductory Sociology	
SOC 3004	Social Inequality	
RLCL 1004	Introduction to Religion and Culture	
COMM 2084	Media and Society	
HUM/RLCL 3204	Multicultural Communication	
PSCI/IS 1024	Comp Gov & Politics	
PSCI/IS/GEOG 2054	Introduction to World Politics	
PSCI 3255 & PSCI 3256	The Politics of Race, Ethnicity and Gender and The Politics of Race, Ethnicity and Gender	
ART 3174	Introduction to Archaeology	
CINE 4144	Topics in Cinema Studies	
HORT 2184	Plants, Places, and Cultures in a Global Context	
GEOG 3104	Environmental Justice, Resources and Development	
HTM 3484	Socio-Cultural Impacts of Tourism	
Capstone Experience Required Course		
ART 4104	Interpretation of Visual Arts	3
Total Credits		**18**

Graduation Requirements

In order to graduate with a Minor in Visual Arts and Society, students must complete all courses required for the minor with a minimum GPA of 2.0 or better and maintain an overall GPA of 2.0. Any course taken to fulfill the Pathways Minor in Visual Arts and Society will count towards the minor GPA.

Viticulture (VITI) Minor

The number of vineyards across Virginia and the mid-Atlantic has expanded rapidly in the last two decades. Virginia has become the 5th largest wine producing region in the United States. The Department of Horticulture has created this minor to serve students interested in grape production and winemaking. The Viticulture minor, though housed in Horticulture, will provide an interdisciplinary learning experience in wine grape production, winemaking, and wine business and marketing, thanks to the cooperation of several other departments. Students of any major can enroll, the semester a course is offered is subject to change; check with the department/instructor for planning purposes.

Code	Title	Credits
Required Courses		
HORT 2234	Environmental Factors in Horticulture	3
HORT 4654	Viticulture	3
CSES 3114/ GEOS 3614	Soils	3
or ENSC 3134	Soils in the Landscape	
Subtotal		9
Restricted Electives		
Select a minimum of nine credits from the following:		9
CSES 3124	Soils Laboratory	
CSES 4214	Soil Fertility and Management	
GEOG 4054	Geography of Wine	
HORT/FST 3114	Wines and Vines (Students must be 21 years or older.)	
HTM 4444	Winery Tourism (Non-HTM Majors enroll during drop/add. Students must be 21 years or older.)	
PPWS 4104	Plant Pathology (4)	
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		9
Total Credits		**18**

Graduation Requirements

Notes:

- **Minimum credits to complete minor**= 18
- **Minimum GPA Requirement** of 2.0 for courses taken towards the minor
- At minimum, 6 of the Restrictive Elective Credits must be at the at 3XXX and/or 4XXX level
- Some courses listed on this checksheet may have pre-requisites, please consult the Course Catalog or check with your advisor.

War and Society (WAS) Minor

Code	Title	Credits
I. Required Minor Courses		
Select a minimum of 9 credits of the following:		9
HIST 2534	America at War	
HIST 3014	The American Revolution	
HIST 3054	The American Civil War	
HIST 3174	Native American History	
HIST 3254	The Vietnam War	
HIST 3274	The Greek City	
HIST 3284	The Roman Revolution	
HIST 3304	The World of Alexander the Great	
HIST 3314	The Later Roman Empire	
HIST 3344	Early Modern and Reformation History, 1500-1650	
HIST 3374	French Empire	
HIST 3364	The Age of Revolution and Napoleon	

HIST 3484	Nazi Germany: History and Memory	
HIST/JUD/RLCL 3494	The Holocaust	
HIST/RLCL 3504	The Age of The Crusades	
HIST 3534	Modern Military History	
HIST 3544	World War II	
HIST 3564	The Cold War	
HIST 3604	Russia to Peter the Great	
HIST 3614	Imperial Russia	
HIST 3644	Twentieth-Century Russia	
HIST 3654	Arab-Israeli Conflict	
HIST 3664	Revolutionary China	
HIST 3714	War and Medicine	
Subtotal		9
II. Approved Electives		
Select a maximum of 9 hours of the following:		9
A. History Electives		
Select up to six hours of the following:		
HIST 1115/1116	History of the United States	
HIST 1024	Ancient History	
HIST 1025/1026	Introduction to European History	
HIST 1214	History of the Modern World	
HIST 1215/1216	Intro to World History	
HIST 1224	Mesoamerica and the Andes	
HIST 1354	Conflict and Security in Modern East Asia	
HIST 1515/1516	History of Africa	
HIST 2184	History of the Balkans	
HIST 2346	History of the Middle East	
HIST 2364	History of Japan	
HIST/RLCL 2384	Gandhi in the Making of Modern India	
HIST 2484	Modern Germany	
HIST/STS 2716	History of Technology	
HIST 3334	The Renaissance World, 1350-1500	
B. Interdisciplinary Electives		
Select up to six hours of the following:		
International Studies (IS)/Political Science (PSCI):		
IS/PSCI/GEOG 2034	Geography of Global Conflict	
IS/PSCI/FST 2044	Food, War and Conflict	
IS/PSCI 3134	Global Conflict and War	
IS/PSCI 3135	Strategies of Modern Warfare	
IS/PSCI 3136	Strategies of Modern Warfare	
IS/PSCI 3184	Human Security	
IS/PSCI 3634	Human Rights: Global Issues	
IS/PSCI 3694	Far-right Violence in the United States	
IS/PSCI 3704	National Security Strategy	
IS/PSCI 3734	National Security	
IS/PSCI 3735		
IS/PSCI 3736		
IS/PSCI 3795	Global Terrorism and Counterterrorism	
IS/PSCI 3796	Global Terrorism and Counterterrorism	
IS/PSCI 4024	Seminar in Diplomacy and Security	
IS/PSCI 4734	Theories and Practices of International Conflict Management	
Political Science:		
PSCI 3564	Violent Political Change	
Religion and Culture (RLCL):		
RLCL/IS 2474	Religion and Violence	
Management (MGT):		
MGT 3804	Topics for Cadet Global Leadership Studies	
Naval Science (MN):		
MN 2104	Seapower and Maritime Affairs	
MN 3204	Evolution of Warfare	
MN 4204	Amphibious Warfare	
Military Science (MS):		
MS 4006	Military Science IV, Army Reserve Officer Training Corps	
Aerospace Science (AS):		
AS 4215	National Security Forces in Contemporary American Society	
Peace Studies and Violence Prevention (PSVP):		
PSVP 2044	Peace and Violence	
PSVP 2444	Conflict Resolution, Mediation and Peacebuilding	
Sociology (SOC):		
SOC 3854	Globalization: Sociological Perspectives	
SOC 4044	Military Sociology	
Subtotal		9
Total Credits		**18**

Graduation Requirements

To earn a minor in **War and Society**, a student must satisfactorily complete a minimum of 18 credits from the approved list of required courses and electives and achieve a minimum 2.0 GPA in all courses taken to satisfy the minor. No more than 6 credits of 1xxx courses may count towards the minor. No more than 50% of the graded course credit required for the War and Society may be double-count by a student also enrolled in a History Major or Minor. Substitutions are allowed for independent studies, special studies courses and undergraduate research, if the topic is appropriate and if the advisor has granted permission. All courses are 3 credits.

Watershed Management (WSM) Minor

Code	Title	Credits
A. Required Core		
FREC 4354	Forest Soil and Watershed Management	3
or UAP 4374	Land Use and Environment: Planning and Policy	
ALS/WATR 4614	Watershed Assessment, Management, and Policy	2
Subtotal		5

B. Additional Courses

1. Watershed Hydrology		
Select one of the following:		3
BSE 3324	Small Watershed Hydrology	
BSE 4224	Field Methods in Hydrology	
CEE 4304	Hydrology	
CEE 4314	Groundwater Resources	
CEE 4324	Open Channel Flow	
FREC/WATR 3104	Principles of Watershed Hydrology	
GEOS 4804	Groundwater Hydrology	
LAR 3154	Watershed Sensitive Site Design and Construction	
Subtotal		3
2. Watershed Water Quality		
Select one of the following:		3
BSE 3334	Nonpoint Source Pollution Assessment and Control	
BSE 4304	Introduction to Watershed Modeling	
CSES 4644	Land-based Systems for Waste Treatment	
ENSC 4314	Water Quality	
FREC/WATR 3754	Watersheds and Water Quality Monitoring	
Subtotal		3
3. Watershed Ecology		
Select one of the following:		3
BIOL 4004	Freshwater Ecology	
BIOL 4164	Environmental Microbiology	
BIOL/ENT 4354	Aquatic Entomology	
CSES/ENSC 4444	Managed Ecosystems, Ecosystem Services, and Sustainability	
FREC 4374	Forested Wetlands	
FIW 4614	Fish Ecology	
Subtotal		3
4. Watershed Geospatial Information Systems		
Select one of the following:		3
BSE 4344	Geographic Information Systems for Engineers	
FREC 4114	Information Technologies for Natural Resource Management	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
FREC/WATR 4244	Hydroinformatics	
GEOG 2084	Principles of Geographic Information Systems	
GEOG/GEOS 4354	Introduction to Remote Sensing	
Subtotal		3
5. Watershed Law, Policy, and Planning		
Select one of the following:		3
AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics	
AAEC 4344	Sustainable Development Economics	
FREC/WATR 4464	Water Resources Policy and Economics	
GEOG/WATR 2004	Water, Environment, and Society	
LAR 3044	Land Analysis and Site Planning	
UAP 4184	Community Involvement	
UAP 4344	Law of Critical Environmental Areas	
Subtotal		3
Total Credits		**20**

Wetland Science (WESC) Minor

Code	Title	Credits
Required Course for Basic Soil		**3-4**
CSES 3114/ GEOS 3614	Soils	
And		
CSES 3124/ GEOS 3624	Soils Laboratory	
Or		
ENSC 3134	Soils in the Landscape	
Subtotal		3-4
Required Courses for Wetland Science (Choose 2)		**6**
CSES 4854	Wetland Soils and Mitigation	
ENSC 4244	Ecological Restoration	
FIW 4534	Ecology and Management of Wetland Systems	
FREC 4374	Forested Wetlands	
FREC 4784	Wetland Hydrology and Biogeochemistry	
Subtotal		6
Required Electives (Choose 3)		**9**
BIOL 2804	Ecology	
BIOL 4004	Freshwater Ecology	
BSE 3324	Small Watershed Hydrology	
BSE 3334	Nonpoint Source Pollution Assessment and Control	
CSES 3614	Soil Physical and Hydrological Properties	
ENSC 3604	Fundamentals of Environmental Science	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC 4164	Environmental Microbiology	
ENSC 4314	Water Quality	
ENSC 4764	Bioremediation	
FREC/WATR 3104	Principles of Watershed Hydrology	
FREC 4354	Forest Soil and Watershed Management	
Subtotal		9
Total Credits		**18-19**

Graduation Requirements

- Minimum credits to complete minor =18
- Minimum from CSES or ENSC courses = 9
- Minimum GPA requirement of 2.0 for courses taken towards the minor

- Some courses listed for this minor may have pre-/co-requisites, please consult the University Course Catalog, or check with your advisor.

Wildland Fire Ecology (WLFE) Minor

Code	Title	Credits
Required Minor Courses		
FREC 2514	Wildland Fire: Ecology and Management [1]	3
FREC 4414	Advanced Wildland Fire Management [1]	3
GEOG 1514	Introduction to Meteorology	3
Subtotal		9
Applied Ecosystem Management Restricted Electives		
Select one of the following:		3-4
FIW 4434	Wildlife Habitat Ecology and Management [1]	3
FREC 3324	Silviculture Principles and Applications [1]	4
FREC 3364	Environmental Silviculture [1]	3
SUBTOTAL		3-4
Ecology Restricted Electives		
Select one of the following:		3
FREC 2004	Forest Ecosystems	3
FREC 2114	Ecology of Appalachian Forests	3
FREC 3314	Forest Ecology and Silvics [1]	3
SUBTOTAL		3
Geospatial Restricted Electives		
Select one of the following:		3
FREC 4114	Information Technologies for Natural Resource Management [1]	3
FREC 4214	Forest Photogrammetry and Spatial Data Processing	3
GEOG/GEOS 4354	Introduction to Remote Sensing	3
SUBTOTAL		3
Biometrics Restricted Electives		
Select one of the following:		3
FREC 3214	Forest Biometrics [2]	3
STAT 3615	Biological Statistics [1]	3
SUBTOTAL		3
Soils Restricted Electives		
Select one of the following:		3
CSES 3114	Soils [2]	3
ENSC 3134	Soils in the Landscape	3
FREC 4354	Forest Soil and Watershed Management [1]	3
FREC 4374	Forested Wetlands [1]	3
GEOG/CSES/GEOS 3304	Geomorphology [1]	3
SUBTOTAL		3
Total		24-25

[1] Courses may have prerequisite or registration restrictions. Check course catalog or timetable for further information.

[2] Course has a required corequisite lab.

Graduation Requirements

Notes for the Minor in Wildland Fire Ecology

1. A minimum G.P.A. average of 2.0 in these courses is required to complete the minor.
2. All courses must be taken for A–F grade unless only offered P/F.
3. Minor coursework aligns with recommendations from Association for Fire Ecology (fireecology.org (http://www.fireecology.org/)).
4. A minimum of 9 credit hours of the graded course credits required for the Minor in Wildland Fire Ecology (WLFE) should not be double-counted in a student's major.

Steps for Completing the Minor in Wildland Fire

1. Sign up for the minor in the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall).
2. When you request or update your DARS, include the minor so that it will check your progress on both your major and minor.
3. Once you have enrolled in the minor, you cannot graduate until you either:
   a. satisfy the credit requirements for the minor, or
   b. withdraw from the minor by notifying the Advising Center of the College of Natural Resources and Environment (138 Cheatham Hall) and revising your DARS.

Agriculture & Life Sciences

Our Website (http://www.cals.vt.edu)

Mission

The college creates, integrates, and shares knowledge to enhance:

- Life sciences, food, and agricultural systems
- The economic prosperity and life quality of the greater community
- The stewardship and health of land, water, and air for future generations
- Student learning through diverse, hands-on, experiential opportunities

Vision

We address current and emerging issues in agricultural and life sciences by building on the land-grant commitment of developing leaders and creating and sharing knowledge through diverse, hands-on applications.

Values

The College of Agriculture and Life Sciences embraces the following core values:

- A commitment to inclusive and diverse communities
- Freedom of inquiry
- Mutual respect
- Lifelong learning
- *Ut Prosim* (That I May Serve)
- Personal and institutional integrity
- A culture of continuous improvement
- Integrated scholarship across the land-grant missions
- International engagement
- Interdisciplinary collaboration

Undergraduate Programs

In the College of Agriculture and Life Sciences, our ambition to help communities thrive is at the center of our identity. We have identified four major strengths of CALS—food, health, economy, and environment—that we will continue to exercise as we seek to help communities thrive. Using these strengths, our work will address many of the grand challenges facing our world, including comprehensive health and wellness, community empowerment, predictive environmental solutions, cultivating lifelong learners, and resilience and efficiency through innovation. There is room for us to excel and grow while focusing on the theme of building thriving communities. By working together, we can all thrive.

The undergraduate program in the college is organized into majors designed for students with widely different interests. These majors permit the student to achieve a satisfactory degree of specialization while providing the fundamentals necessary for continuing professional growth after graduation.

Freshman students may enter the college with the designation LFSC (Exploring Life Sciences). Upon completion of the freshman year, a college major should be selected.

Students who plan to transfer to Virginia Tech and major in the College of Agriculture and Life Sciences after two years of community college enrollment are encouraged to complete as many of the Pathways curriculum courses as possible before they transfer.

Minors Offered

- Agribusiness and Entrepreneurship
- Agricultural and Applied Economics
- Animal and Poultry Sciences
- Crop and Soil Environmental Sciences
- Dairy Science
- Development and International Trade
- Ecosystems for Human Well-Being
- Entomology
- Environmental Economics
- Environmental Science
- Equine Science
- Food, Agriculture, and Society
- Food Science and Technology
- Global Food Security and Health
- Horticulture
- Integrative Health and Wellness
- Leadership and Social Change
- Plant Health Sciences
- Teaching and Learning in Agriculture
- Turfgrass Management
- Viticulture
- Wetland Science

College-wide Minors

The college offers three transdisciplinary and experiential-based minors: Food, Agriculture, and Society (FAS), Integrative Health and Wellness (IHW), and Global Food Security and Health (GFSH). The FAS and GFSH are Pathways minors. A cross-campus team of faculty, staff, students, and community partners collaborate to deliver these minors.

Living-Learning Community (LLC) and Residential College (IRC)

Meraki LLC

Students will be encouraged to put their passion, creativity, and soul into finding themselves through well-being.

Leadership and Social Change RC

The mission of the Leadership and Social Change Residential College is to offer students a theoretical foundation combined with the practical knowledge and skills necessary to lead in a complex global environment.

Experiential Learning

Students are encouraged to participate in internship and co-op opportunities to gain relevant work experience prior to graduation. Departmental career advisors can help students identify opportunities. In most cases, students receive credit for qualifying work experience. Enrichment studies include research field study opportunities, study abroad and summer laboratory experiences outside the university.

Research opportunities and experiencing the excitement of discovery can play an important part in undergraduate training in science. College of Agriculture and Life Sciences departments offer diverse research opportunities in which students may choose to participate. Individuals interested in undergraduate research should contact faculty members in the departments where they wish to conduct research.

The Academic Programs Office in the college, in cooperation with the Global Education Office, offers several avenues for students both in and outside the college to gain international knowledge and experience. These study opportunities allow students and faculty to become aware of and develop basic knowledge of food, fiber, and environmental issues in the world. Specific activities include study abroad programs and courses, international internships, formal student exchange programs, seminars and workshops on campus, and courses in the college, which focus on international topics. All of the departments in the college offer education abroad opportunities and students wishing to explore these opportunities should contact their advisor.

Advising

Students are assigned an advisor for their major during academic advising and course registration at Virginia Tech. In order to put together a solid plan to finish a degree, advising is critical. Advisors in the College of Agriculture and Life Sciences are among the best resources on campus. In fact, they consistently win awards for the quality of advising they provide. Virginia Tech is a big university, but advisors make it seem like a small town where everyone knows everyone else.

Each year approximately 50% of our graduating students continue their education in graduate or professional school. Pre-health advising (e.g. pre-dentistry, pre-medicine, and pre-veterinary) is coordinated through the Office of Health Professions located in Career and Professional Development.

Career advising is available from a number of sources. The university offers centralized career services and on-campus interviewing. The College of Agriculture and Life Sciences works with employers interested in hiring students with degrees from the college and organizes employer

panels and information sessions. The university office of Career and Professional Development offers several job/career fairs throughout the year, which gives students the opportunity to connect with potential employers.

Career and Professional Development also offers each student access to a computerized program to connect students with potential employers. Undergraduate students who are seeking any type of career-related employment, including internships, co-ops, career-related summer employment, and permanent positions are eligible to use this system.

Scholarships

College and departmental scholarships are available for students enrolled in the College of Agriculture and Life Sciences. Applications are accepted through the University's Scholarship Central. Descriptions and deadlines are available on the Scholarships and Financial Aid website at www.finaid.vt.edu (http://www.finaid.vt.edu).

Honor Societies

Gamma Sigma Delta - Gamma Sigma Delta is an organization having as its objectives the advancement of agriculture in all its phases, the maintenance and improvement of the relations of agriculture and related sciences to other industries, and the recognition of the responsibilities of those engaged in all aspects of agriculture to humankind. Our Society seeks to encourage high standards of scholarship and worthy achievements in all branches of the agricultural and related sciences as well as a high degree of excellence in the practice of agricultural pursuits.

Phi Kappa Phi - Phi Kappa Phi has chapters on nearly 300 select college and university campuses in North America and the Philippines. Membership is by invitation only to the top 10 percent of seniors and graduate students and 7.5 percent of juniors. Faculty, professional staff, and alumni who have achieved scholarly distinction also qualify. The Society's mission is "To recognize and promote academic excellence in all fields of higher education and to engage the community of scholars in service to others."

Phi Beta Kappa - Phi Beta Kappa is the oldest and most prestigious honor society dedicated to recognizing excellence in the liberal arts and sciences. Students in the College of Agriculture and Life Sciences who have exhibited outstanding academic ability in eligible coursework may be eligible for selection to Phi Beta Kappa.

Graduate Programs

All College of Agriculture and Life Sciences departments offer graduate degrees at both the Master and Ph.D. levels. There is also an Online Master of Agricultural and Life Sciences (OMALS) degree program (with 8 different concentrations (https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cals.vt.edu%2Facademic-programs%2Fonline%2Fconcentrations.html&data=05%7C02%7Cataylor%40vt.edu%7C58f7012b6cb44198d4b708dc7917ead2%7C6095688410ad40fa863d4f32c1e3a37a%7C0%7C0%7C638518390849955733%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=D%2BlEvmDItFzjRVJr2OTDIRHLvsKVYUlWQ6rC5NW9geA%3D&reserved=0)) that is an approved accelerated undergraduate to graduate degree (https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cals.vt.edu%2Facademic-programs%2Fonline%2Facceleratedmasters.html&data=05%7C02%7Cataylor%40vt.edu%7C58f7012b6cb44198d4b708dc7917ead2%7C6095688410ad40fa863d4f32c1e3a37a%7C0%7C0%7C638518390849969991%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=nXeasAb%2FmdwkXdGrM2FtqFSazrs3e1DWD7OjFDrYFko%3D&reserved=0). Complete information on these programs including descriptions of graduate courses can be found in the Graduate Catalog (https://catalog.vt.edu/graduate/).

- Agribusiness Major with Agribusiness Management Option (p. 503)
- Agribusiness Major with Veterinary Business Management Option (p. 504)
- Agricultural and Extension Education Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/agricultural-leadership-community-education/agricultural-extension-education/)
- Animal and Poultry Sciences Major (p. 552)
- Associate of Agriculture with Applied Agricultural Management Option (p. 514)
- Associate of Agriculture with Landscape and Turf Management Option (p. 515)
- Biochemistry Major (p. 522)
- Community Economic Development Major (p. 505)
- Community Leadership and Development Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/agricultural-leadership-community-education/community-leadership-development/)
- Crop and Soil Sciences Major (p. 567)
- Dairy Science Major with Dairy Business Management Option (p. 554)
- Dairy Science Major with Dual Emphasis Option (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/animal-sciences/dairy-science-dual-emphasis/)
- Dairy Science Major with Science/Prevet Option (p. 556)
- Ecological Restoration Major (p. 569)
- Environmental Economics, Management, and Policy Major (p. 507)
- Environmental Horticulture Major (p. 572)
- Environmental Science Major (p. 574)
- Exercise and Health Sciences Major (p. 542)
- Food and Health Systems Economics Major (p. 508)
- Food Science and Technology Major with Food and Beverage Fermentation Option (p. 531)
- Food Science and Technology Major with Food and Health Option (p. 532)
- Food Science and Technology Major with Food Business Option (p. 533)
- Food Science and Technology Major with Science Option (p. 535)
- Integrated Agriculture Technologies Major (p. 576)
- International Trade and Development Major (p. 510)
- Landscape Design and Turfgrass Science Major (p. 578)
- Nutrition and Dietetics Major (p. 544)
- Plant Science Major (p. 581)

Dean: Alan Grant
Associate Dean & Director of Academic Programs: Susan S. Sumner
Associate Dean & Director of Virginia Agricultural Experiment Station: Mary Burrows

Associate Dean & Director of Virginia Cooperative Extension: Michael Gutter

Associate Dean & Director of Global Programs: Thomas L. Thompson
Assistant Dean of Inclusion, Diversity, and Equity: Chevon N. Thorpe

Undergraduate Course Descriptions (ALS)

ALS 1004 - Agriculture, the Arts and Society (1 credit)
Interpretive strategies applied to agriculture and the visual arts. Artistic representations of agriculture, farming, rural livelihoods, and agrarian landscapes. Exploration of global agricultural challenges balancing the production of food, fiber, and fuel. Apply principles of design and art using photography medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1014 - Gardens as Art (1 credit)
Interpretive strategies applied to agriculture and gardening design. Artistic representations of agriculture and landscaping. Exploration of global agricultural challenges balancing the production of food, gentrification, and location. Application of principles design and elements of visual art using gardening medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1024 - Digitized Agriculture (1 credit)
Interpretive strategies applied to agricultural art and design. Artistic representations of agriculture and nature. Agriculture through digital art (narrative art, stories, and data visualization). Exploration of global agricultural challenges balancing the production of food, fiber, fuel- and location. Elements, methods of interpreting, and principles and application of art and design using a narrative medium.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1034 - The Aesthetics of Food (1 credit)
Food as a method of study for art and design. Taste, smell, color, shape, presentation, memory, and packaging of food related to human cultural experience. Food presentation, marketing, and food choices in global context influence how people experience food.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1234 - CALS First Year Seminar (1 credit)
Exploration of topics related to the College of Agriculture and Life Sciences (CALS) from a multidisciplinary perspective with a focus on communication and teamwork, problem-solving, inquiry, and integration. Students explore resources to promote academic success, investigate careers and academic areas, and develop a comprehensive plan of study. Freshman and transfer students only.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 1984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

ALS 2204 - Sustainable Food Systems (3 credits)
Introduction to the economic, social, and ecological foundations of civic agriculture. Topics include industrialization, localized food systems, and citizen participation in civic agriculture. Emphasis will be given to a range of civic agriculture models, strategies, and hands-on approaches to establish, retain and strengthen community-based food and agriculture systems, locally- nationally-globally.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2304 - Comparative Animal Physiology and Anatomy (4 credits)
Comparative anatomy and physiology of domestic mammals and birds including cell neural, musculoskeletal, respiratory, cardiovascular, urinary, and endocrine systems.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

ALS 2404 - Biotechnology in A Global Society (3 credits)
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening.
Prerequisite(s): (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H) and (CHEM 1015 and CHEM 1016)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 2404

ALS 2504 - Animals in Society (3 credits)
Animal well-being and behavior, human-animal interactions, ethical responsibilities to animals, animal care, behavior, disease, and pain recognition. Current topics concerning companion animals, domestic animals, and wildlife.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2604 - Intro to Interdisciplinary Research Practices (3 credits)
Introduction to formal undergraduate research and basic research methods. Engagement in interdisciplinary collaboration via team research projects. Exploration of scholarly literature, topic development, information evaluation, citation and data management, research ethics, and scientific communication. Connections to advanced information and digital literacy topics such as research impact and digital repositories. Formal proposal development and presentation.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 2984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

ALS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 3104 - Animal Breeding and Genetics (3 credits)
Principles of genetics applied to improvement of domestic animals: factors affecting genetic improvement of economically relevant traits, estimation of breeding values, heritability, genetic correlations, relationships, inbreeding, crossbreeding, genetic abnormalities, genomic selection, and gene editing; ethical reasoning in animal breeding decisions.
Prerequisite(s): BIOL 1105 and (STAT 2004 or STAT 3005 or STAT 3615) and (APSC 1454 or DASC 2474 or DASC 2484)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3204 - Animal Nutrition and Feeding (3 credits)
Characteristics, sources, digestion, absorption, and metabolism of water, carbohydrates, lipids, proteins, vitamins, and minerals. Feeding systems for livestock, poultry and companion animals.
Prerequisite(s): ALS 2304 and (CHEM 1036 or CHEM 1036H or CHEM 1016)
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3304 - Physiology of Reproduction (3 credits)
Physiological mechanisms that control and affect reproductive processes in domestic species. Investigation of the anatomy and physiology of the reproductive systems from cellular to whole-body levels with a particular emphasis on implications for reproductive function.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 3314 - Physiology of Reproduction Lab (1 credit)
Investigation of the structure and function of reproductive systems of domestic species. Practical application of this knowledge is then taught through demonstrations, hands-on experiences and assignments exploring current farm-animal production systems.
Corequisite(s): ALS 3304
Instructional Contact Hours: (0 Lec, 3 Lab, 1 Crd)

ALS 3404 - Ecological Agriculture: Theory and Practice (3 credits)
Presents an overview of historic and modern agricultural practices. Surveys the principles of ecology in the context of managed ecosystems, civic agriculture, and food systems. Explores ecologically based practices and their use in holistic and integrated agricultural systems.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4204 - Concepts in Community Food Systems (3 credits)
Examination of the economic, political, socio-cultural, health and environmental issues related to community food systems and agricultural practices. Topics include local, regional and global food systems development, food production and biotechnology, food sovereignty and security, and population and environmental health. Analyze models, strategies, and policies within local, national and global food systems.
Prerequisite(s): ALS 2204
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4214 - Capstone: Civic Agriculture and Food Systems (3 credits)
Multidisciplinary, experiential community-based course focusing on civic agriculture-food systems. Work in partnership with community stakeholders to propose viable solutions to real world issues revolving around civic agriculture and food systems. Connect with communities locally, regionally or globally.
Prerequisite(s): ALS 2204 and ALS 3404 and ALS 4204
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4224 - Food, Agriculture, and Society Capstone Seminar (1 credit)
Explore the interplay between food, agriculture, and society from interdisciplinary perspectives. Engage in student-led discussions, presentations, and critical thinking and synthesizing of capstone experiences embedded within the Food, Agriculture, and Society Pathways minor curriculum. Integrate research, study abroad, internships, or other experiential learning initiatives to gain practical insights toward a more just and sustainable food system. Pre: (ALS 2204 and HIST 1084) and any Study Abroad, Independent Study, or Undergraduate Research course regardless of subject designator.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 4244 - Global Food Security and Health Capstone Experience (3 credits)
Food security and its relationship to human and global health challenges. Role of geography, economics, climate, politics, trade, and culture. Ethical issues and challenges to improving global food security and health. Creatively analyze, synthesize, and evaluate learned knowledge. Participate in successful discourse related to global food security and health.
Prerequisite(s): CSES 2244 and AAEC 3204
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 4554 - Neurochemical Regulation (3 credits)
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet.
Prerequisite(s): (ALS 2304 or BIOL 3404) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 4554

ALS 4574 - Social Behavior of Birds and Mammals (3 credits)
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural, companion and laboratory settings are discussed.
Prerequisite(s): ALS 3104 or BIOL 2004 and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 4574

ALS 4614 - Watershed Assessment, Management, and Policy (2 credits)
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: WATR 4614

ALS 4714 - Global Seminar (1 credit)
Student-centered internet-based course including text and real-time video conferencing among students at collaborating institutions in the United States and Canada. Focus is contemporary North American environmental sustainability issues based on student-prepared case studies. Pre-requisite: Junior or Senior Standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: HORT 4714

ALS 4814 - Nutritional Neuroscience (3 credits)
Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity.
Prerequisite(s): NEUR 2026 or ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 4814

ALS 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 5024 - Building Multicultural Competence in Agriculture and Life Sciences (1 credit)
Diversity and inclusion within agriculture and life sciences in academic settings and communities: university, national, and global. Virginia Tech Principles of Community and appropriate avenues of redress. Shared responsibilities and issues of privilege, bias, power, prejudice, and discrimination. Governmental and institutional policies and their effects on diversity and inclusion. Pre: Graduate Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 5094 - Effective Grant Writing for the Biomedical aand Behavioral Sciences (1 credit)
The grant writing process and developing student skills for successful grant writing to support research enterprises. Students will prepare a mock research grant proposal for obtaining funds from the National Institutes of Health, National Science Foundation, or the US Department of Agriculture and participate in panel review of grant proposals of peers.
Prerequisite(s): APSC 5004 or (ALS 5064 or BIOL 5064 or BCHM 5064 or PPWS 5064)
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 5104 - Communicating Research and Leadership in Agriculture and Life Sciences (2 credits)
Principles and strategies for effective leadership and communication in agricultural and life sciences (ALS). Analysis, synthesis and translation of research information for use in practical settings. Effective ALS knowledge. Evaluation of research design and methodology in action research. Pre: Graduate standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

ALS 5116 - Nutrition (3 credits)
Digestion, absorption and metabolism of nutrients in animals including humans. 5115: Digestive physiology; digestion and absorption; bioenergetics; and carbohydrate and lipid metabolism with emphasis on substrate sources, interrelationships, and factors affecting utilization and metabolism. Graduate Standing required. 5116: Absorption, metabolism and function with emphasis on physiological and biochemical aspects of protein, amino acid, vitamins, and minerals; epidemiological, biochemical, cellular or molecular methodologies useful for study of macronutrients and micronutrients and their biological functions also will be covered.
Prerequisite(s): ALS 5115
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5134 - Community-Based Applications of Qualitative Inquiry (3 credits)
Community-based applications of qualitative inquiry in Agricultural and Life Sciences. Qualitative methodology in community-based research with a focus on ethics and inclusivity. Interviews and focus groups. Professional best practices and enhance communication. Best practices for a community approach, interview facilitation, and reporting for professional audiences. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5204 - Research and Information Systems in the Life Sciences (3 credits)
A focus on research techniques and processes for life science professions. Topics include: history of applied life sciences, current structure of the scientific enterprise, the scientific method and quality assurances, researching the literature, scientific writing and presentation of research results, instructional techniques, professionalism, and ethical considerations. Information technology is employed throughout the course. Students learn to use digital technologies for communication, presentation, and publication.
Instructional Contact Hours: (1 Lec, 2 Lab, 3 Crd)

ALS 5214 - Information Systems and Research in the Life Sciences (3 credits)
Research techniques and processes used in the life science professions. History of applied life sciences, structure of the scientific enterprise, the scientific method and quality assurances, researching the literature and critically evaluating information, scientific writing and communication of research results, professionalism, and ethics. Graduate standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5224 - Introduction to Genomic Data Science (3 credits)
Analysis of genomic data for applications in agriculture and life sciences. Computational tools for genomic data processing and quality control. Interpret results from genomic experiments. Summary statistics, machine learning and methods of visualization for genomic data. High Performance Computing (HPC) systems for genomic analysis. Genomic data analysis pipelines. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5234 - Advanced Concepts in Community Food Systems (3 credits)
Examination of the economic, political, social, and cultural issues related to community food systems and agricultural practices. Local and regional food systems development, food production and biotechnology, food sovereignty and security, and population and environmental health. Analysis of models, strategies, and policies of national food systems. Pre: Graduate Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5304 - Advanced Physiology and Anatomy of Domestic Animals (5 credits)
Mammalian physiology and anatomy will be evaluated in domestic animals, laboratory animals, and primates. Emphasis will be on the cardiovascular, renal, respiratory, neural, muscle, and digestive physiology.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (4 Lec, 3 Lab, 5 Crd)

ALS 5324 - Research Ethics in Agriculture and Life Sciences (1 credit)
Principles of and skills development in research ethics to enhance professional preparation in agriculture and life sciences. Pre: Graduate standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 5334 - Professional Communication Agriculture and Life Sciences (1 credit)
Principles of, and skill development in, academic communication to enhance professional preparation in the agricultural and life sciences. Pre: Graduate standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

ALS 5404 - Management and Analysis of Agricultural Experiments (3 credits)
Problem-based learning approach to managing, analyzing, and interpreting experimental data common to agricultural research. Programming for statistical software packages and dissection of algorithms to troubleshoot and revise programming code.
Prerequisite(s): STAT 5615 and STAT 5616
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 5904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 5954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 5964 - Field Work/Practicum (1-12 credits)
Instructional Contact Hours: (1-12 Lec, 1-12 Crd)
Repeatability: up to 12 credit hours

ALS 5974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 5984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 6314 - Endocrinology (3 credits)
Hormones produced in animals and their roles in development, growth, appetite, digestion, metabolism, lactation, reproduction, homeostasis, and behavior. Mechanisms by which hormones act and the factors that regulate the production and action of hormones. Endocrine disorders and hormone-based application in medicine and animal agriculture. Major methodologies in current endocrine research.
Prerequisite(s): ALS 5304 or ALS 5344
Instructional Contact Hours: (3 Lec, 3 Crd)

ALS 6984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALS 7964 - Field Studies (1-12 credits)
Instructional Contact Hours: (1-12 Lec, 1-12 Crd)
Repeatability: up to 12 credit hours

Agricultural and Applied Economics

Our Website (http://www.aaec.vt.edu)

Inspired by our land grant mission and motto *Ut Prosim* (That I May Serve), we teach, conduct research, and distribute findings that empower a diverse audience of students, stakeholders, and alumni to change the world. Our faculty and graduates have expertise in applied economics and agribusiness principles that, in turn, help address the food, financial, health, development, policy, environmental, and social needs in Virginia and beyond.

Students receive a world-renowned education and leave as leaders prepared to serve their communities by addressing the world's most challenging problems. https://aaec.vt.edu/About.html

Major Options

- B.S. in Agribusiness w/ Agribusiness Management Option (AGBM)
- B.S. in Agribusiness w/ Veterinary Business Management Option (VBMG)
- B.S. in Applied Economic Management w/ Environmental Economics, Management, and Policy Major (EEMP)
- B.S. in Applied Economic Management w/ International Trade and Development Major (ITD)
- B.S. in Applied Economic Management w/ Community Economic Development Major (CED)
- B.S. in Applied Economic Management w/ Food and Health Systems Economics Major (FHSE)

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Agribusiness Major with Agribusiness Management Option (p. 503)
- Agribusiness Major with Veterinary Business Management Option (p. 504)
- Community Economic Development Major (p. 505)
- Environmental Economics, Management, and Policy Major (p. 507)

- Food and Health Systems Economics Major (p. 508)
- International Trade and Development Major (p. 510)

Head: Matthew T. Holt
Professors: Jeffrey Alwang, Darrell Bosch, Kevin Boyle, George Davis, Matt Holt, Michael Ellerbrock, Mary Marchant, Bradford Mills, Klaus Moeltner, David Orden, Kurt Stephenson
Associate Professors: Susan Chen, Dixie Watts Dalton, Catherine Larochelle
Assistant Professors: Elinor Benami, John Bovay, Zhenshan Chen, Anubhab Gupta, Xi He, Chanit'a Holmes, Ford Ramsey, Shamar Stewart, Jonathan van Senten, Chi Ta, Wei Zhang
Assistant Professor of Practice: Jennifer Friedel
W.G. Wysor Professor of Agriculture: Jason Grant
John B. and Kristi L. Rowsell Professor: Olga Isengildina-Massa
Instructors: Ryan Musselman
Undergraduate advisor: TBD

Undergraduate Course Descriptions (AAEC)

AAEC 1005 - Economics of the Food and Fiber System (3 credits)
1005: How the individual economic actor makes rational choices as: consumer, producer, firm/farm, saver, investor, employee, employer, manager, trader. Economic principles that underlie exchange in business, government and household transactions. Utility maximization in the U.S. and global food and fiber system under conditions of scarcity. Evaluation of policy issues important to society. 1006: Overview of economic systems: capitalism versus communism, socialism, feudalism, mercantilism. Interrelationships of U.S. economic fiscal and monetary institutions and policies regarding agricultural productivity, business vitality, sustainable development, and human capital formation. Affordability, safety and security of food and fiber, cultural dynamics, consumer welfare, industrial profitability, natural resources conservation, rural economic infrastructure, international trade, and social justice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 1006 - Economics of the Food and Fiber System (3 credits)
1005: How the individual economic actor makes rational choices as: consumer, producer, firm/farm, saver, investor, employee, employer, manager, trader. Economic principles that underlie exchange in business, government and household transactions. Utility maximization in the U.S. and global food and fiber system under conditions of scarcity. Evaluation of policy issues important to society. 1006: Overview of economic systems: capitalism versus communism, socialism, feudalism, mercantilism. Interrelationships of U.S. economic fiscal and monetary institutions and policies regarding agricultural productivity, business vitality, sustainable development, and human capital formation. Affordability, safety and security of food and fiber, cultural dynamics, consumer welfare, industrial profitability, natural resources conservation, rural economic infrastructure, international trade, and social justice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2104 - Personal Financial Planning (3 credits)
Survey of fundamental personal financial planning needs and decisions of young professionals. Introduction to the personal financial planning needs that special household circumstances or non-traditional household situations may precipitate. Application of cash, credit, and debt management principles to household scenarios. Completion of federal income tax forms for individuals. Managing the household's risk exposure. Introduction to investment decisions, particularly related to retirement accounts. Overview of basic estate planning tools and principles. Discussion of the ethical issues related to financial products and decisions.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2434 - Foundations of Agribusiness (3 credits)
Introduction to the primary management tools as they relate to farm production enterprises and agribusinesses. Principles and concepts of preparing farm and agribusiness financial statements and their analysis. Application of budgeting and risk management.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3004 - Agricultural Production and Consumption Economics (3 credits)
The economic principles of production. Applications to decision-making and the allocation of resources for the agricultural firm. Consumer behavior and demand for agricultural products.
Prerequisite(s): (AAEC 1005 or ECON 2005) and (MATH 1025 or MATH 1225)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3014 - Analytical Methods in Applied Economics (3 credits)
Quantitative methods used in applied empirical economic analysis including simple and multiple regression, estimation and application of elasticity, decision analysis, economic simulations, linear programming, and risk analysis. Analysis using spreadsheets stressed.
Prerequisite(s): STAT 3005 or BIT 2405 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3015 - Internship in Agricultural and Applied Economics (1 credit)
Preparation for, and follow-up to, a practical experience in a selected agricultural, resource, or governmental enterprise, which takes place under the direct supervision of an owner, manager, or supervisor. 3015: offers the student a broad management horizon on understanding the value and the process of setting goals and objectives, and provides methods for evaluating ones abilities, interests, and desires for making career-path choices. 3016: provides a forum for students to share work experiences, discuss human resource issues, and apply the problem solving process to a problem or concern witnessed during the internship.
Instructional Contact Hours: (1 Lec, 1 Crd)

AAEC 3024 - Monetary and Global Issues in Applied Economics (3 credits)
Economics of an open economy and its impact on agricultural and natural resource markets. History of the monetary system, national accounts, balance of payments, fiscal and monetary policy, foreign exchange determinants, trade deficits, international finance, globalization and economic growth. Linkages to agricultural policy and commodity markets stressed.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3204 - International Agricultural Development and Trade (3 credits)
Examination of the role of agriculture in less developed countries and how that role is affected by public policies. Dimensions of world food, population, and income problems; theories of economic development and the role of agriculture; traditional agricultural systems and their evolution; agricultural modernization strategies; interactions among natural resources, biofuels, food prices, and sustainable agriculture; the impacts of international trade and aid; and the effects of international development on U.S. agriculture.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3314 - Environmental Law (3 credits)
Principles of law involved in environmental issues, survey of environmental litigation, legislation and administrative rulings. Law topics include natural resources, water pollution, private land use, air pollution, toxic substance, food, drug, pesticides, and biotechnology.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3324 - Environment and Sustainable Development Economics (3 credits)
Sustainable development through an exploration of hard and soft green schools of thought. Hard Green Strategies – reliance on markets, technology, property rights, human ingenuity to increase production efficiency versus Soft Green Strategies-adoption of simpler lifestyles, government subsidies, natural design of buildings (biomimicry), and urban infrastructure to locate public transportation hubs nearest to densely populated neighborhoods to decrease consumption of natural resources. Connecting the influence of place in personal and group identity. Interdisciplinary examination of environmental justice among poor and minority U.S. communities. Social equity distribution of the economic costs and benefits of natural resources management policies. Roles of property rights, economic incentives, religious values, and political power in determining local communities' capacity to control their environmental destiny.
Prerequisite(s): AAEC 1005 or AAEC 1006 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3424 - Value-Based Management in Agribusiness (3 credits)
Focus on finance concepts in the agricultural and environmental sectors. Apply the value-based management principles and financial analysis to industry-related cases. Estimate cost of capital, free cash flow and net present value. Team-based approach on a real-world valuation case.
Prerequisite(s): AAEC 1005 and AAEC 1006 and ACIS 2115
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3454 - Small Business Management and Entrepreneurship (3 credits)
Characteristics of small business and entrepreneurs, and their economic importance. Development and operation of a small business, including concepts and principles such as franchising, business plans, capital acquisition, venture capital, financial and administrative control, marketing, human resource and operations management. Taxation, legal, insurance and ethics in small business.
Prerequisite(s): AAEC 2434 or ACIS 2115 or MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3504 - Marketing Agricultural Products (3 credits)
Structure of the agricultural marketing system with emphasis on factors determining farm level prices. Emphasis on how markets coordinate consumer desires and producer costs through marketing channels. Impact of market structure, grades, information, product form, and advertising on farm prices. International trade impacts on producers, consumers, agribusiness, and government.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3514 - Agricultural Futures and Options (3 credits)
The role of agricultural futures and options in risk management strategies for producers and agribusiness firms and in the price discovery process. Fundamental supply-demand and technical analysis of the markets and pricing processes. Development and applications of effective price risk management strategies.
Prerequisite(s): AAEC 1005 and AAEC 1006 and AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3604 - Agricultural Law (3 credits)
Legal problems of farm and agribusiness management. Practical application of principles of contracts, negligence, debt instruments and commercial transactions of the farm and agribusiness organization. Selected state and federal laws regulating the farm and agribusiness sector; basic animal laws including state and federal regulation of agricultural sector.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

AAEC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4135 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4135

AAEC 4136 - International Economics (3 credits)
4135: International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136: International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4136

AAEC 4204 - Food and Agricultural Policy (3 credits)
Examination of the role of agriculture in developed economies and how agriculture is affected by policy decisions in the public sector. Emphasis will be placed on the economic impacts of policies on the producers and consumers of agricultural products: price supports, food stamps, tariffs and quotas.
Prerequisite(s): AAEC 1005 and AAEC 1006
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4314 - Environmental Economic Analysis and Management (3 credits)
Quantitative methods and computer-aided tools used in the economic analysis of environmental/natural resource issues. Economic concepts and analytical tools will be applied to realistic, problem-solving situations. Topics include cost effectiveness analysis, benefit-cost analysis, economic simulations, and statistical analysis.
Prerequisite(s): AAEC 3324 or ECON 4014 or FREC 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4324 - Rural and Regional Development Policy (3 credits)
Description of rural areas, their economic structure, and conditions for broad-based economic development. Emphasis on the role of markets in the development process. Introduction to tools to evaluate policies and programs, identify distributional impacts, identify appropriateness for long-term sustainable development, and analyze tradeoffs between policy goals. Alternatives to public financing in rural areas.
Prerequisite(s): AAEC 1005 and AAEC 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4334 - Applications Rural Development (1 credit)
Evaluation of policy alternatives and programs for the development of rural areas. Intensive use of analytical techniques, including spreadsheet analysis of trends and changes over time, shift-share analysis of economic change, creation of indices of distribution and poverty for rural areas, creation and use of economic base multipliers, construction, use and interpretation of input-output models.
Prerequisite(s): AAEC 1005 and AAEC 3004
Corequisite(s): AAEC 4324
Instructional Contact Hours: (1 Lec, 1 Crd)

AAEC 4344 - Sustainable Development Economics (3 credits)
Sustainable development concepts are critically explored particular emphasis on implications for domestic and international sustainable development agriculture and for economic development. Students investigate case studies illustrating problems of sustainable development and potential policy solutions.
Prerequisite(s): AAEC 3324 or AAEC 3004 or ECON 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4354 - Energy Economics (3 credits)
Theoretical and quantitative economic analyses of individual, regional, and global demand and supply of renewable and nonrenewable energy. Markets examined include solar, wind, oil, natural gas, electricity, and nuclear. Policies reviewed include those used to regulate energy prices, tax carbon emissions, and promote technology adoption. Countries studied include the U.S., Europe, and Asia, encompassing both developed and developing nations. Pre: Junior Standing.
Prerequisite(s): AAEC 1005 or AAEC 1006 or ECON 2005 or ECON 2006 or MATH 1025 or MATH 1225
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4404 - Agricultural Management and Problem-solving (3 credits)
Capstone course for students interested in agribusiness management. Application of concepts, tools, and principles including management, finance, marketing, economic theory, and quantitative methods to applied agricultural decisions. Application of knowledge on selected agricultural projects that enhance team-building, written, and oral communication skills. Senior Standing required.
Prerequisite(s): AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4414 - Applied Economic Problem-Solving (3 credits)
Application of economic training and skillsets to real-world needs identified by clientele. Team problem-solving of financial, marketing, production, legal and regulatory, and human resources issues unique to the agriculture sector. Facilitated experiential learning environment focused on student-motivated solutions to economic risk management. This course may be repeated once.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4424 - Ag Financial Management (3 credits)
Principles and concepts of preparing agricultural financial statements. Analysis of these statements following professional farm financial guidelines. Economic concepts applied to management of agricultural enterprises. Leasing, purchasing, borrowing, and lending decisions in agriculture. Agricultural applications of budget, risk management and mitigation, and loan structuring.
Prerequisite(s): AAEC 1005 and AAEC 2434 and (FIN 3104 or AAEC 3424)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4434 - Commodity Investing by Students (2 credits)
Students make real world investment decisions in agricultural and energy commodities, execute trades, evaluate their performance and report to the VT Foundation. This student-run organization provides leadership opportunities as well as collaboration and networking experiences. Restricted to COINS members. May be repeated with different content up to 8 credit hours. This course is Pass/Fail.
Prerequisite(s): AAEC 4504
Instructional Contact Hours: (2 Lec, 2 Crd)
Repeatability: up to 8 credit hours

AAEC 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4464, WATR 4464

AAEC 4484 - Applied Economic Forecasting (3 credits)
Forecasting economic, agricultural and environmental data using basic linear and non-linear time series models. Programming and computational implementation of time series forecasting model selection techniques and practical applications.
Prerequisite(s): (AAEC 1005 or AAEC 1006) and (STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4504 - Agricultural Price and Market Analysis (3 credits)
Estimation of agricultural supply, demand, and price relationships. Determination of market potential for new products. Students identify problem, collect data, estimate statistical relationship(s), interpret results, and write research report. Use of probability distribution in marketing strategy development.
Prerequisite(s): AAEC 3004 and STAT 3005 or STAT 3615 or BIT 2405
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4514 - Advanced Agribusiness Marketing (1-4 credits)
Applying concepts, principles, and analytical tools in developing a marketing plan for an existing or new agricultural product or service. Students will define the market, perform competitive marketing analysis, outline market assumptions and objectives, and perform a three-year financial evaluation of the action plan. Course can be repeated once.
Prerequisite(s): AAEC 2434 and AAEC 3504
Corequisite(s): 3504 or 3004.
Instructional Contact Hours: (1-4 Lec, 1-4 Crd)
Repeatability: up to 4 credit hours

AAEC 4804 - Elementary Econometrics (3 credits)
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations.
Prerequisite(s): AAEC 1005 and (STAT 3615 or STAT 3005 or STAT 3604 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4804

AAEC 4814 - Food and Health Economics (3 credits)
Microeconomics of food, nutrition, and health. Overview of nutrition, nutrition recommendations, and implications for economics based decisions. Individual and household food consumption and health production models. Farm to consumer market linkage models with nutrition and health implications Effectiveness of food and nutrition interventions and policies. Cost-benefit and cost-effectiveness analysis of health interventions. Pre: Senior Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

AAEC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAEC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Agribusiness Major with Agribusiness Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3454	Small Business Management and Entrepreneurship [1]	3
AAEC 3504	Marketing Agricultural Products [1]	3
AAEC 3604	Agricultural Law	3
AAEC 4424	Ag Financial Management [1]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3
ACIS 2115	Principles of Accounting	3
Subtotal		21
Major Requirements		
ALS 1234	CALS First Year Seminar	1
AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		10
Option Required Courses		
Major Option Core Courses		
AAEC 3004	Agricultural Production and Consumption Economics [1]	3
AAEC 3015	Internship in Agricultural and Applied Economics	1
AAEC 4514	Advanced Agribusiness Marketing [1]	3
Select one of the following: [2]		3
AAEC 3514	Agricultural Futures and Options [1]	
AAEC 4504	Agricultural Price and Market Analysis [1]	
AAEC 4804	Elementary Econometrics [1]	
AAEC 4484	Applied Economic Forecasting [1]	
Restricted Electives		
Select three AAEC courses (6 hours must be at the 3000 level or higher)		9
Subtotal		19
Area of Specialization and Free Electives		
A. Area of Specialization		

AAEC undergraduate advisor must approve area of specialization courses. Students should consider obtaining a minor or double major to satisfy the area of specialization. At least 9 hours must be at the 3000 level or higher (unless noted otherwise for a minor in another academic department). Students majoring in Agribusiness are not eligible to minor in any of the AAEC minors. [3]		18
B. Free Electives		
Select 7 hours		7
Subtotal		25
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus (5F) [4]	
or MATH 12	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking (5F)	
CS 1064	Introduction to Programming in Python (5F)	
FREC 1004	Digital Planet (5F)	
STAT 1014	Data in Our Lives (5F)	
STAT 3615	Biological Statistics (5A) [1]	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select 3 credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select 3 credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

[2] Students with interest in GIS may also take GEOG 2084 Principles of Geographic Information Systems or BSE 4344 Geographic Information Systems for Engineers

[3] AAEC minors: Agribusiness Management and Entrepreneurship (ABAE), Environmental Economics (EECO), Development and International Trade (DAIT), Agricultural and Applied Economics (AEMN) and Commodity Market Analytics (CMAM) .

[4] Students considering graduate school in applied economics are encouraged to take MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable.

Satisfactory progress: By the end of the academic year in which the student has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of

1. an overall GPA of at least 2.0;
2. at least 30 credits that apply to the Pathways to General Education, and
3. 9 semester credits of departmental requirements.

Graduation Requirements

Program Total Hours: 120 credit hours required for graduation with this degree.

GPA: In major calculation is from all AAEC and ECON classes taken. An overall GPA of at least 2.0 is required to meet the University's minimum standard for good academic standing. Overall and in-major GPA's of at least 2.00 are required for graduation.

Foreign Language Requirements

Foreign Language Requirement: Students who do not successfully complete at least two units of a single foreign language, classical language, or American Sign Language during high school must successfully complete six semester hours of a single college-level foreign or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the Undergraduate Catalog for details.

1.

Agribusiness Major with Veterinary Business Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3454	Small Business Management and Entrepreneurship [1]	3
AAEC 3504	Marketing Agricultural Products [1]	3
AAEC 3604	Agricultural Law	3
AAEC 4424	Ag Financial Management [1]	3

AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3
ACIS 2115	Principles of Accounting	3
Subtotal		21
Major Requirements		
ALS 1234	CALS First Year Seminar	1
AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		10
Option Required Courses		
Major Option Core Courses		
BCHM 2024	Concepts of Biochemistry [1]	3
or BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	
or BCHM 4115	General Biochemistry	
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2604	General Microbiology [1]	3
BIOL 2614	General Microbiology Laboratory [1]	1-2
PHYS 2205	General Physics [1]	3
PHYS 2206	General Physics [1]	3
PHYS 2215	General Physics Laboratory [1]	1
PHYS 2216	General Physics Laboratory [1]	1
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [1]	3
CHEM 2536	Organic Chemistry [1]	3
CHEM 2545	Organic Chemistry Laboratory [1]	1
CHEM 2546	Organic Chemistry Laboratory [1]	1
HNFE 2204	Medical Terminology [1]	3
Subtotal		36-37
Free Electives		
Select credits needed to complete 120 hours		8
Subtotal		8
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
ENGL 1106	First-Year Writing	3
COMM 2004	Public Speaking	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus	
or MATH 122	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking	
CS 1064	Introduction to Programming in Python	
FREC 1004	Digital Planet	
STAT 1014	Data in Our Lives	
STAT 3615	Biological Statistics	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

[1] **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

1.

Community Economic Development Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3004	Agricultural Production and Consumption Economics [1]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3

AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
AAEC 3015	Internship in Agricultural and Applied Economics	1
ACIS 2115	Principles of Accounting	3
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		19
Major Requirements		
ALS 1234	CALS First Year Seminar	1
AAEC 3604	Agricultural Law	3
or AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics [1]	3
AAEC 4324	Rural and Regional Development Policy [1]	3
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
Select two of the following:		6
AAEC 3204	International Agricultural Development and Trade [1]	
AAEC 4314	Environmental Economic Analysis and Management [1]	
ECON 3034	Economics of Poverty and Discrimination [1]	
Subtotal		19
Analytical Methods		
Select one of the following:		3
AAEC 4804	Elementary Econometrics [1]	
GEOG 2084	Principles of Geographic Information Systems	
or BSE 4344	Geographic Information Systems for Engineers	
STAT 4214	Methods of Regression Analysis [1]	
AAEC 4484	Applied Economic Forecasting [1]	
Subtotal		3
Restricted Electives		
Select nine hours of AAEC courses (six hours must be at the 3000 level or higher)		9
Subtotal		9
Area of Specialization		
Area of Specialization (18 hours) – AAEC advisor must approve area of specialization courses and the student must file an area of specialization form with the AAEC undergraduate office. Students should consider minors or double majors. At least 9 hours must be at the 3000 level or higher (unless noted otherwise for a minor in another academic department). Students majoring in Community Economic Development are not eligible to minor in any of the AAEC minors [3]		18
Subtotal		18
Free Electives		
Select seven credit hours of free electives		7
Subtotal		7
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [3]	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus (5F) [3]	
or MATH 12	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking (5F)	
CS 1064	Introduction to Programming in Python (5F)	
FREC 1004	Digital Planet (5F)	
STAT 1014	Data in Our Lives (5F)	
STAT 3615	Biological Statistics (5A) [1]	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credit hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

[2] AAEC minors: Agribusiness Management and Entrepreneurship (ABAE), Environmental Economics (EECO), Development and International Trade (DAIT), Agricultural and Applied Economics (AEMN), and Commodity Market Analytics (CMAM).

[3] Students considering graduate school in applied economics are encouraged to take MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable.

Satisfactory progress: By the end of the academic year in which the student has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of

1. an overall GPA of at least 2.0;
2. at least 30 credits that apply to the Pathways to General Education, and
3. 9 semester credits of departmental requirements.

Graduation Requirements

Program Total Hours: 120 credit hours required for graduation with this degree.

GPA: In major calculation is from all AAEC and ECON classes taken. An overall GPA of at least 2.0 is required to meet the University's minimum standard for good academic standing. Overall and in-major GPA's of at least 2.00 are required for graduation.

Acceptable Substitutions

Can take any of the classes below as an AAEC-restricted elective:

- APS 3464 Appalachian Communities /AHRM 3464 Appalachian Communities /GEOG 3464 Appalachian Communities /HD 3464 Appalachian Communities /HUM 3464 Appalachian Communities /SOC 3464 Appalachian Communities /UAP 3464 Appalachian Communities [1]
- ECON 4074 Labor Economics [1]
- ECON 4044 Public Economics [1]
- ECON 4054 Public Finance [1]
- UAP 4374 Land Use and Environment: Planning and Policy [1]

Foreign Language Requirement

Foreign Language Requirement: Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the Undergraduate Catalog for details.

1.

Environmental Economics, Management, and Policy Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3004	Agricultural Production and Consumption Economics [1]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3
AAEC 3015	Internship in Agricultural and Applied Economics	1
AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
ACIS 2115	Principles of Accounting	3
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		19
Major Requirements		
ALS 1234	CALS First Year Seminar	1
AAEC 3314	Environmental Law	3
AAEC 3324	Environment and Sustainable Development Economics [1]	3
AAEC 4314	Environmental Economic Analysis and Management [1]	3
AAEC 4324	Rural and Regional Development Policy [1]	3
ENSC 1015	Foundations of Environmental Science	3
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
Subtotal		19
Analytical Methods		
Select one of the following:		2-3
AAEC 4504	Agricultural Price and Market Analysis [1]	
GEOG 2084	Principles of Geographic Information Systems	
or BSE 4344	Geographic Information Systems for Engineers	
AAEC 3514	Agricultural Futures and Options [1]	
AAEC 4804	Elementary Econometrics [1]	
ALS 4614	Watershed Assessment, Management, and Policy [1]	
AAEC 4484	Applied Economic Forecasting [1]	
Subtotal		2-3
Restricted Electives		
Select nine hours of AAEC electives (six hours must be at the 3000 level or higher)		9
Subtotal		9
Area of Specialization		
AAEC advisor must approve area of specialization courses and the student must file an area of specialization form with the AAEC undergraduate office. Students should consider minors or double majors. At least nine hours must be at the 3000 level or higher (unless noted otherwise for a minor in another academic department). Students majoring in Environmental Economics Management and Policy are not eligible to minor in any of the AAEC minors. [2]		18
Subtotal		18
Free Electives		
Select credits needed to complete 120 hours		8
Subtotal		8
Pathways to General Education		
Some Pathways courses may also fulfill departmental requirements, but the credit hours may not be counted twice.		

Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select two courses in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [3]	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus (5F) [3]	
or MATH 1226	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking (5F)	
CS 1064	Introduction to Programming in Python (5F)	
FREC 1004	Digital Planet (5F)	
STAT 1014	Data in Our Lives (5F)	
STAT 3615	Biological Statistics (5A) [1]	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

1 **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.

2 AAEC minors: Agribusiness Management and Entrepreneurship (ABAE), Environmental Economics (EECO), Development and International Trade (DAIT), and Agricultural and Applied Economics (AEMN).

3 Students considering graduate school in applied economics are encouraged to take MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable.

Satisfactory Progress

By the end of the academic year in which the student has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of

1. an overall GPA of at least 2.0;
2. at least 30 credits that apply to the Pathways to General Education, and
3. 9 semester credits of departmental requirements.

Graduation Requirements

Program Total Hours

120 credit hours required for graduation with this degree. The total number of credit hours may vary depending on whether Pathways courses are used to meet specific requirements.

GPA: In major calculation is from all AAEC and ECON classes taken. An overall GPA of at least 2.0 is required to meet the University's minimum standard for good academic standing. Overall and in-major GPA's of at least 2.00 are required for graduation.

Foreign Language Requirement

Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the Undergraduate Catalog for details.

1.

Food and Health Systems Economics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3004	Agricultural Production and Consumption Economics [1]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3
AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
AAEC 3015	Internship in Agricultural and Applied Economics	1
ACIS 2115	Principles of Accounting	3
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		19

Major Requirements		
ALS 1234	CALS First Year Seminar	1
APSC 1454	Introduction to Animal and Poultry Science [1]	3
AAEC 3504	Marketing Agricultural Products [1]	3
AAEC 4504	Agricultural Price and Market Analysis [1]	3
AAEC 4814	Food and Health Economics [1]	3
SPES 2244	World Crops: Food and Culture [1]	3
ECON 4214	Economics of Health Care [1]	3
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
FST 2014	Introduction to Food Science	2
HNFE 1004	Foods, Nutrition And Exercise	3
PHS 2004	Introduction to Public Health	3
Select one of the following:		3
APSC 3134	Animal Agriculture and the Environment	
CSES 2244	Agriculture, Global Food Security and Health	
FST 2244	Topics in Food Science and Technology [1]	
HNFE 2544	Functional Foods for Health	
PHS 3014	Introduction to Environmental Health	
Select one of the following:		3
AAEC 3314	Environmental Law	
AAEC 3604	Agricultural Law	
AAEC 3454	Small Business Management and Entrepreneurship [1]	
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
Subtotal		36
Capstone Course		
Select one of the following:		3
AAEC 4404	Agricultural Management and Problem-solving [1]	
AAEC 4414	Applied Economic Problem-Solving [1]	
PHS 4054	Concepts in One Health [1]	
Subtotal		3
Area of Specialization		
AAEC advisor must approve area of specialization courses and the student must file an area of specialization form with the AAEC undergraduate office. Students should consider minors or double majors. At least 9 hours must be at the 3000 level or higher (unless noted otherwise for a minor in another academic department). Students majoring in the AAEC Department are not eligible to minor in any of the AAEC minors. [2]		17
Subtotal		17
Pathways to General Education		
Some Pathways courses may also fulfill departmental requirements, but the credit hours may not be counted twice.		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select two courses in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select two lecture courses in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [3]	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus (5F) [3]	
or MATH 1226	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking (5F)	
CS 1064	Introduction to Programming in Python (5F)	
FREC 1004	Digital Planet (5F)	
STAT 1014	Data in Our Lives (5F)	
STAT 3615	Biological Statistics (5A) [1]	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1. **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.
2. AAEC minors: Agribusiness Management and Entrepreneurship (ABAE), Environmental Economics (EECO), Development and International Trade (DAIT), Agricultural and Applied Economics (AEMN), and Commodity Market Analytics (CMAM).
3. Students considering graduate school in applied economics are encouraged to take MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable.

Satisfactory progress: By the end of the academic year in which the student has attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of

1. an overall GPA of at least 2.0;
2. at least 30 credits that apply to the Pathways to General Education, and
3. 9 semester credits of departmental requirements.

Graduation Requirements

Program Total Hours: 120 credit hours required for graduation with this degree.

GPA: In major calculation is from all AAEC and ECON classes taken. An overall GPA of at least 2.0 is required to meet the University's minimum standard for good academic standing. Overall and in-major GPA's of at least 2.00 are required for graduation.

Foreign Language Requirement

Foreign Language Requirement: Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the Undergraduate Catalog for details.

International Trade and Development Major

Code	Title	Credits
Degree Core Requirements		
AAEC 2434	Foundations of Agribusiness [1]	3
AAEC 3004	Agricultural Production and Consumption Economics [1]	3
AAEC 3024	Monetary and Global Issues in Applied Economics [1]	3
AAEC 3015	Internship in Agricultural and Applied Economics	1
AAEC 3014	Analytical Methods in Applied Economics [1]	3
or BIT 2406	Introduction to Business Statistics, Analytics, and Modeling	
or STAT 3006	Statistical Methods	
or STAT 3616	Biological Statistics	
ACIS 2115	Principles of Accounting	3
ENGL 3774	Business Writing [1]	3
or ENGL 3764	Technical Writing	
or ENGL 3754	Advanced Writing and Research	
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
Subtotal		19
Major Requirements		
ALS 1234	CALS First Year Seminar	1
AAEC 3204	International Agricultural Development and Trade [1]	3
AAEC 3324	Environment and Sustainable Development Economics [1]	3
AAEC 4324	Rural and Regional Development Policy [1]	3
AAEC 3424	Value-Based Management in Agribusiness [1]	3
or FIN 3104	Introduction to Finance	
or ACIS 2116	Principles of Accounting	
IS 2054	Introduction to World Politics	3
IS 2064	The Global Economy and World Politics	3
Subtotal		19
Analytical Methods		
Select one of the following:		3
AAEC 4804	Elementary Econometrics [1]	
AAEC 4504	Agricultural Price and Market Analysis [1]	
GEOG 2084	Principles of Geographic Information Systems [1]	
or BSE 4344	Geographic Information Systems for Engineers	
ECON 3254	Applied Econometrics [1]	
ECON 4304	Introduction to Econometric Methods [1]	
AAEC 4484	Applied Economic Forecasting [1]	
Subtotal		3
Restricted Electives		
Select nine hours of the following (6 hours must be at the 3000 level or higher):		9
AAEC		
ECON 4135	International Economics	
Subtotal		9
Area of Specialization		
AAEC advisor must approve area of specialization courses and the student must file an area of specialization form with the AAEC undergraduate office. Students should consider minors or double majors. At least 9 hours must be at the 3000 level or higher (unless noted otherwise for a minor in another academic department). Students majoring in the AAEC Department are not eligible to minor in any of the AAEC minors. [2]		18
Subtotal		18
Free Electives		
Select number of credits needed to complete 120 hours		7
Subtotal		7
Pathways to General Education		
The total number of credit hours will vary depending upon whether Pathways courses are used to meet specific requirements above. Some Pathways courses may also fulfill departmental requirements, but the credit hours may not be counted twice.		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select two courses in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select two lecture courses in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [3]	3
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
MATH 1026	Elementary Calculus (5F) [3]	
or MATH 1226	Calculus of a Single Variable	
CS 1014	Introduction to Computational Thinking (5F)	

CS 1064	Introduction to Programming in Python (5F)	
FREC 1004	Digital Planet (5F)	
STAT 1014	Data in Our Lives (5F)	
STAT 3615	Biological Statistics (5A) [1]	3
or STAT 3005	Statistical Methods	
or BIT 2405	Introduction to Business Statistics, Analytics, and Modeling	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1. **Pre-requisites:** Some courses required for this major have pre-/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisites and enrollment requirements.
2. AAEC minors: Agribusiness Management and Entrepreneurship (ABAE), Environmental Economics (EECO), Development and International Trade (DAIT), Agricultural and Applied Economics (AEMN), and Commodity Market Analytics (CMAM).
3. Students considering graduate school in applied economics are encouraged to take MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable.

1.

Agricultural Technology

Our Website (http://www.cals.vt.edu)

Overview

The Agricultural Technology Program offers a concentrated academic experience for individuals pursuing an associate degree in preparation for careers in the agriculture and green industries. Students can specialize in Applied Agricultural Management or Landscape and Turfgrass Management.

Applied Agricultural Management (AAM)

- Agribusiness
- Crop Production
- Livestock Production

The AAM specialty provides students with a balanced education that prepares them for diverse job opportunities.

The animal science curriculum includes courses in genetics, nutrition, reproduction, and management. It focuses on the biological and economic aspects of animal production and management. Soils, forages, mechanics and chemical application courses round out the AAM curriculum.

Business courses provide instruction in financial recordkeeping, professional selling, personnel management, strategic marketing, whole business planning, and information systems, focusing on strategic management and economic issues of the agricultural industry. Laboratories stress the use of modern management methods for problem solving.

The crop science curriculum provides students knowledge and hands-on experiences relative to Virginia's major crop and forage systems. Students learn about cash crop rotations and grazing management as well as precision agriculture, integrated pest management, pesticide application, and pesticide safety. Students gain experience using the latest technologies in precision agriculture through labs held in partnership with leaders from the farm equipment industry.

Landscape and Turf Management (LTM)

- Landscape Management
- Turf Management

In the LTM specialty, students prepare for a career in the green industry — including landscape design, landscape contracting, golf course management, horticulture production and nursery management, and sports turf management. They learn about turfgrass and landscape installation, maintenance, and management.

The LTM curriculum focuses on developing well-rounded students who are in high demand by many branches of the green industry. Students learn about various types of plants, turfgrass management, soils and nutrient management, landscape design, and Irrigation and drainage.

Additional courses are offered in horticulture production, hardscaping, landscape contracting, golf and sports turf management, integrated pest management, and chemical application. Special study classes allow students to work on the Virginia Tech golf course and athletic fields and compete in national competitions. A strong core of business courses is also offered. Laboratories for each class focus on hands-on learning and expose students to a range of applied landscape and turf management skills.

Course Requirements for Major

All students are required to complete an occupational internship for academic credit to provide practical experience in a work environment. The internship is divided into three semesters: a one-credit preparatory course, a summer 10-week/400-hour component, and a one-credit post internship course. Students, in consultation with faculty members, select their internships that may be located anywhere in the United States or abroad.

All admission offers for this program are made though the Agricultural Technology Program. Foreign language is not a requirement of this program. Recommended high school courses include English, Algebra I, and Geometry (minimum), two lab sciences, and a computer class. Students are encouraged to pursue an Advanced or Standard Diploma from high school. Agricultural Technology students have the same rights and privileges as other students at Virginia Tech, except for membership in the Corps of Cadets and participation in NCAA sports. Selected agricultural technology courses can be transferred to a bachelor's degree program in the College of Agriculture and Life Sciences at Virginia Tech.

Satisfactory Progress towards Degree

Students must achieve and maintain a cumulative 2.00 GPA each semester;

All AT courses will be used in the calculation of the GPA.

- Associate of Agriculture with Applied Agricultural Management Option (p. 514)
- Associate of Agriculture with Landscape and Turf Management Option (p. 515)

Director: Susan Sumner
Senior Instructors[1]**:** R. Kohl and T. Martin
Advanced Instructor: W. Gwaltney
Instructor: R. Jeter, J. Dickerson, and M. Holder
Assistant Program Directors: T. Martin and R. Kohl

[1] In addition, selected faculty members from departments within the College of Agriculture and Life Sciences teach courses in the program.

Undergraduate Course Descriptions (AT)

AT 0124 - Ag Mach Mech (3 credits)
Introduction to the operation and maintenance of internal combustion engines, field machinery, tractor and power units, and shop to include the fundamentals of gas and arc welding.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0144 - Communication Skills (4 credits)
Written and oral communication skills, including business and technical writing, public speaking, and interpersonal communication. Instruction and practice in the application of communication skills for business and agriculture. Emphasis on effective use of word processing and email software.
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

AT 0164 - Introduction to Animal Science (4 credits)
Study of animal products, production methods, and management systems for beef, sheep, horses, dairy, swine and poultry. Classroom instruction, demonstrations, and hands-on experience with livestock and poultry.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

AT 0174 - Fundamentals of Turfgrass Mgmt (4 credits)
Turfgrass identification, morphology, adaptations, and management systems for parks, lawns, athletic fields, roadsides, and golf courses. Mowing, irrigation, fertilization, soil management, pest management, and other practices that impact turf management. Turfgrass management planning utilizing Integrated Pest Management and Best Management Practices.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

AT 0184 - Plant Science for Agriculture and the Green Industries (3 credits)
Basic botanical and chemical principles and their applications to sound plant production and management practices. Emphasis on practical experiences in laboratory and field settings.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0194 - AT Internship (1-6 credits)
Practical experience in a selected agricultural enterprise, under the direct supervision of owner, manager, or supervisor. Internship will be evaluated by faculty member. Written reports of work experience activities are required. Completion of at least 28 credits with a minimum GPA of 2.00 required.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

AT 0204 - Applied Agricultural Personal Finance (3 credits)
Examines issues of agricultural financial principles, financing individual and family needs. This course includes: financial institutions, budgeting, banking services, investing, borrowing, credit management, types of insurance, personal taxes, expense management, personal investments, and time value of money.
Instructional Contact Hours: (3 Lec, 3 Crd)

AT 0224 - Agricultural Technology Management of Personnel and Sales (3 credits)
Principles and practices in recruitment, selection, training, compensation, evaluation, discipline, and dismissal of employees for businesses in the agricultural and green industries. Emphasis is placed on employer/employee relationships. Fundamental understanding of professional selling in the agricultural and green industries. Preparation of sales presentations for agricultural products.
Instructional Contact Hours: (3 Lec, 3 Crd)

AT 0234 - Intro Agribus & Financial Mgt (3 credits)
Functions of agribusiness enterprises within the U.S. economic framework. Economic systems, cooperatives, essential elements of business organization, management tools for decision-making, creating financial statements, business planning, development and analysis of budgets, investing in a business, and time value of money.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0274 - Agribus Marktng & Entrepreneur (3 credits)
Principles of marketing through the agribusiness industry including the strategic management of products, distribution, promotion, and pricing to improve business performance. Entrepreneurship is explored as a career alternative including methods for acquiring necessary start-up capital. Solving business problems utilizing finance and marketing tools.
Prerequisite(s): AT 0234
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0294 - Livestock Merchandising (2 credits)
A comprehensive study of the principles and activities involved in successfully promoting and merchandising livestock. A livestock auction will be held at the conclusion of the course to provide experiences in advertising, salesmanship, facility development, sale management, and budgeting. Pre: Second year student.
Instructional Contact Hours: (2 Lec, 2 Crd)

AT 0324 - Livestock Reproduction (2 credits)
Principles and practices of reproductive management used to maximize reproductive efficiency in dairy and beef cattle, sheep, swine, and horses. Must be second year student in Agriculture Technology.
Prerequisite(s): AT 0164
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

AT 0344 - Grain Crop Management (3 credits)
Principles and practices of efficient grain crop management with an emphasis on Virginia cropping systems.
Prerequisite(s): AT 0184 and AT 0414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0354 - Feeds and Feeding (2 credits)
Principles and practices of livestock feeding. Anatomy and physiology of ruminant and non-ruminant digestive systems. Emphasis on nutrient requirements and ration formulation. Computerized ration formulation and evaluation.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

AT 0364 - Ath Fld Prac- Football/Soccer (2 credits)
Learn the principles and techniques of game preparation and routine maintenance on the NCAA football and soccer fields at Virginia Tech. Students laboratory experience will be field work with the Virginia Tech Athletic Department staff. Focusing the football and soccer fields during the NCAA competition season.
Instructional Contact Hours: (6 Lab, 2 Crd)

AT 0374 - Ath Fld Prac- Base/Softball (2 credits)
Learning the principles and techniques of game preparation and routine maintenance on the NCAA baseball and softball fields at Virginia Tech. Students laboratory experience will be field work with the Virginia Tech Athletic Department Staff. Focusing on the baseball and softball fields during the NCAA competition season.
Instructional Contact Hours: (6 Lab, 2 Crd)

AT 0394 - Golf Course Practicum (2 credits)
Principles and techniques of golf course preparation and maintenance required for a high-end golf course. Off-site fieldwork, laboratory experience. Practice maintenance procedures needed to rejuvenate the golf course from the summer season.
Prerequisite(s): AT 0174
Instructional Contact Hours: (0 Lec, 6 Lab, 2 Crd)

AT 0404 - Irrigation and Drainage (3 credits)
Principles applied to solving irrigation and drainage problems. Emphasis placed on hydraulics, irrigation design, irrigation scheduling, and components including heads, valves, controllers, backflow prevention, wire, pipe, and fittings.
Corequisite(s): AT 0114
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0414 - Soils and Nutrient Management (3 credits)
Physical, chemical, and biological properties of soils; soils suitability for production of a range of agricultural crops to include turfgrass and landscape plants. Properties of common liming, biosolid, manure, and fertilizer materials with emphasis on their environmental impacts. Soil and plant sampling procedures and the analysis of soil tests. Nutrient management plans.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0424 - Nutrient Management Planning (3 credits)
Basic soil science and fertility principles necessary for crop production. Environmental impacts of phosphorus and nitrogen, environmentally sensitive site considerations, regulations, and how to write a nutrient management plan.
Prerequisite(s): AT 0184 and AT 0414
Instructional Contact Hours: (3 Lec, 3 Crd)

AT 0434 - Pest Management (4 credits)
Identification, classification, and life cycles of economically important insects, plant pathogens, and weeds. Pest management methods: cultural practices, chemical control, biological control, host plant resistance, etc.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

AT 0444 - CAD for Landscaping (2 credits)
In-depth study and hands-on experience essential to landscape horticulture graphics in a digital format using industry appropriate software.
Prerequisite(s): AT 0684
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

AT 0464 - Forages and Forage Animal Systems (3 credits)
Use of cool-season and warm-season forage species currently grown in Virginia in forage-based animal systems.
Prerequisite(s): AT 0184 and AT 0414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0484 - Precision Ag and Data Mgmt (2 credits)
Introduction to various tools and applications related to precision agriculture. Collection, analysis, and effective interpretation and utilization of precision agriculture data, including soil test data, precision fertilizer, and pesticide data.
Prerequisite(s): AT 0184 and AT 0344
Instructional Contact Hours: (2 Lec, 2 Crd)

AT 0494 - Dairy Management (3 credits)
Concepts of efficient and profitable management of modern dairy herds. Application of basic principles of business, milking, mastitis control, milk quality, herd replacements, feeding, breeding, reproduction, herd health, housing, and milk marketing management to profitable dairy farming.
Prerequisite(s): AT 0164
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0504 - AT First Year Experience (2 credits)
Orientation course for first semester AT students providing skills, resources and fundamental knowledge to enhance learning experiences and support success. Introduction to study skills and good testing habits, program requirements, opportunities and careers within options, and skills that are essential to become leaders in the agriculture and green industries.
Instructional Contact Hours: (2 Lec, 2 Crd)

AT 0514 - Cont Ag Issues (3 credits)
A survey course designed to acquaint the student with the concerns and critical issues impacting the field of agriculture. Contemporary agricultural issues will be explored.
Instructional Contact Hours: (3 Lec, 3 Crd)

AT 0524 - Whole Farm Planning (2 credits)
Principles of whole farm and agricultural business planning including creating business plans, personal financial plans, and farm/business transition plans. Identifying and solving real-world agribusiness problems utilizing proper planning.
Prerequisite(s): AT 0234
Instructional Contact Hours: (2 Lec, 0 Lab, 2 Crd)

AT 0544 - Horticulture Production (3 credits)
Production of vegetable, fruit, flowering, and nursery crops, including propagation of these crops. Focus is on the culture of these commodities as alternative agricultural crops, including environmental and cultural requirements for high quality production.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0554 - Chemical Application (2 credits)
Proper application of pesticides and other agricultural chemicals used in landscape and turf management and in production agriculture; including application methods, equipment calibration and configuration, occupational health and safety, and pesticide laws and regulations.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

AT 0564 - Herbaceous Plants (2 credits)
Identification, selection, requirements, and uses of herbaceous plant materials commonly found in landscapes; includes annuals, perennials, bulbs, and grasses.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

AT 0574 - Woody Landscape Plants (2 credits)
Identification and uses of evergreen and deciduous woody plant materials common in the landscape industry; including trees, shrubs, and ground covers; proper plant selection and location in the landscape site.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

AT 0614 - Beef and Sheep Management (3 credits)
Beef cattle/sheep production and management. Emphasis on genetics, nutrition, herd health, reproduction, and marketing to optimize performance and profit. Management and flock decisions based on economic and business principles. Practical experience enhanced through laboratory activities.
Prerequisite(s): AT 0164
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0624 - Horse Management (3 credits)
Horse production and management. Emphasis on genetics, nutrition, herd health, reproduction, and marketing to optimize performance and profit. Management decisions based on economic and business principles. Practical experience enhanced through laboratory activities.
Prerequisite(s): AT 0164
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0654 - Golf Course Design and Rules (2 credits)
Principles of golf course design and rules of the game, including: evolution, fairness, progression, hazards, shot value, and safety. The United States Golf Associations rules of golf will be covered.
Instructional Contact Hours: (2 Lec, 2 Crd)

AT 0664 - Golf & Sports Turf Management (3 credits)
Management of turfgrass on modified soil. Advanced management techniques and manipulation of nutrition and cultural practices to reduce plant stress or increase plant tolerance. Intensive turfgrass pest identification, life cycles, environmental conditions, and methods of effective control. Integrated pest management and best management practices.
Prerequisite(s): AT 0174
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

AT 0674 - Spanish for the Green Industry (3 credits)
Dialogue-based language skills focused on vocabulary and grammatical structures common to agricultural and green industries. Includes vocabulary and contexts specific to activities in greenhouse, nursery, turf, and landscape environments. Elements of Spanish culture are included throughout the course. Pre: Prior study in Spanish is helpful but not required.
Instructional Contact Hours: (3 Lec, 3 Crd)

AT 0684 - Landscape Design (3 credits)
Principles and practices involved in the development and interpretation of landscape designs; proper selection and use of landscape construction materials and methods of construction. Introduction to utilizing computer-aided drafting.
Prerequisite(s): AT 0564
Corequisite(s): AT 0574
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0694 - Landscape Contracting (3 credits)
Interpreting a landscape design and properly installing plant materials. Preparing bids for customers using cost accounting principles. Maintaining and renovating landscapes as well as exploring careers and business opportunities in the landscaping industry.
Prerequisite(s): AT 0564 and AT 0574
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AT 0704 - Turfgrass Capstone Project (3 credits)
Capstone course for the Landscape Turfgrass Management option of the Agricultural Technology program. Problem based learning course to evaluate selected turfgrass problems for stakeholders such as golf courses, athletic fields and parks and recreation departments facility administrators. Students to look holistically at a problem and use critical thinking, experiences and knowledge from previous class work to create custom solutions. For second-year students only.
Prerequisite(s): AT 0664
Instructional Contact Hours: (1 Lec, 4 Lab, 3 Crd)

AT 0714 - Hardscape Materials & Instal (2 credits)
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction. Restricted to students in the Landscape & Turf Management option in the Agricultural Technology Program.
Instructional Contact Hours: (6 Lab, 2 Crd)

AT 0724 - Landscape Skills Practicum (1 credit)
This course provide an introduction to a multitude of skills that are important for success in the landscape industry. Each session is set in a competitive environment emphasizing the development of a selection of hands-on skills, including safe equipment operation, landscape and hardscape installation, management and estimating techniques, and arboculture methods.
Instructional Contact Hours: (2 Lab, 1 Crd)

AT 0734 - Risk Management in Agriculture (2 credits)
Fundamentals of managing risk in agriculture, particularly for production of row crops and livestock, including sources of risk and cost/benefit analysis of various risk mitigation strategies. Commodity futures contracts and options as price risk management tools. Government policies, particularly crop and livestock insurance provisions of the current Farm Bill.
Corequisite(s): AT 0234
Instructional Contact Hours: (2 Lec, 2 Crd)

AT 0974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AT 0984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AT 0994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Associate of Agriculture with Applied Agricultural Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AT 0144	Communication Skills	4
AT 0184	Plant Science for Agriculture and the Green Industries	3
AT 0194	AT Internship	3

AT 0204	Applied Agricultural Personal Finance	3
AT 0224	Agricultural Technology Management of Personnel and Sales	3
AT 0234	Intro Agribus & Financial Mgt	3
AT 0414	Soils and Nutrient Management	3
AT 0504	AT First Year Experience	2
Subtotal		24
Option Required Courses		
Required Courses for Applied Agricultural Management Option (10 credits)		
AT 0164	Introduction to Animal Science	4
AT 0274	Agribus Marktng & Entrepreneur [1]	3
AT 0464	Forages and Forage Animal Systems [1]	3
Subtotal		10
Choose One Emphasis: Crop, Livestock, or Agribusiness (10 credits each emphasis)		
Required (3 credits) and Electives (7 credits) for Crop Emphasis (10 credits total)		
Required Course for Crop Emphasis (Required 3 credits)		*3*
AT 0344	Grain Crop Management [1]	
Electives for Crop Emphasis (choose at least 7 credit hours)		*7*
AT 0424	Nutrient Management Planning [1]	
AT 0434	Pest Management	
AT 0484	Precision Ag and Data Mgmt	
AT 0554	Chemical Application	
Electives for Livestock Emphasis (choose at least 10 credits)		**10**
AT 0294	Livestock Merchandising	
AT 0324	Livestock Reproduction [1]	
AT 0354	Feeds and Feeding	
AT 0494	Dairy Management	
AT 0614	Beef and Sheep Management	
AT 0624	Horse Management	
Electives for Agribusiness Emphasis (choose at least 10 credit hours)		**10**
AT 0294	Livestock Merchandising	
AT 0344	Grain Crop Management	
AT 0424	Nutrient Management Planning	
AT 0434	Pest Management	
AT 0494	Dairy Management	
AT 0524	Whole Farm Planning [1]	
AT 0614	Beef and Sheep Management	
AT 0624	Horse Management	
AT 0734	Risk Management in Agriculture [1]	
Free Electives (choose enough credits to bring total to at least 64)		
AT 0124	Ag Mach Mech	
AT 0324	Livestock Reproduction	
AT 0344	Grain Crop Management	
AT 0354	Feeds and Feeding	
AT 0424	Nutrient Management Planning	
AT 0434	Pest Management	
AT 0484	Precision Ag and Data Mgmt	
AT 0494	Dairy Management	
AT 0514	Cont Ag Issues	
AT 0524	Whole Farm Planning	
AT 0544	Horticulture Production	
AT 0554	Chemical Application	
AT 0614	Beef and Sheep Management	
AT 0624	Horse Management	
AT 0674	Spanish for the Green Industry	
AT 0734	Risk Management in Agriculture	
Subtotal		27
Total Credits		**64**

[1] Prerequisites/corequisites may apply for these elective courses - see your advisor.

Students must achieve a 2.0 cumulative GPA for all hours attempted (including transfer, advanced placement, and credit by examination). All Agricultural Technology courses will be used in calculation of the GPA.

Graduation Requirements

Each student must complete 64 credit hours, as delineated on the program requirements, with a minimum overall GPA and an in-major GPA of 2.0. The in-major GPA calculation will be based on all courses with an AT designator.

Please consult the University Course Catalog or see your academic advisor to develop a plan of study that includes necessary prerequisites.

Foreign Language Requirement

No requirement.

Associate of Agriculture with Landscape and Turf Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AT 0144	Communication Skills	4
AT 0184	Plant Science for Agriculture and the Green Industries	3
AT 0194	AT Internship	3
AT 0204	Applied Agricultural Personal Finance	3
AT 0224	Agricultural Technology Management of Personnel and Sales	3
AT 0234	Intro Agribus & Financial Mgt	3
AT 0414	Soils and Nutrient Management	3
AT 0504	AT First Year Experience	2
Subtotal		24
Option Required Courses		
Required Courses for Landscape and Turf Management Option (21 credits)		
AT 0174	Fundamentals of Turfgrass Mgmt	4
AT 0404	Irrigation and Drainage [1]	3
AT 0434	Pest Management	4

AT 0554	Chemical Application	2
AT 0564	Herbaceous Plants	2
AT 0574	Woody Landscape Plants	2
AT 0674	Spanish for the Green Industry (satisfies SCHEV social sciences requirement)	3
AT 0724	Landscape Skills Practicum	1
Select One Emphasis: Landscape or Turfgrass		**6**
Landscape Emphasis: Must take the following two courses: (6 credits)		
AT 0684	Landscape Design [1]	
AT 0694	Landscape Contracting [1]	
Turfgrass Emphasis: Must take the following two courses: (6 credits)		
AT 0664	Golf & Sports Turf Management [1]	
AT 0704	Turfgrass Capstone Project [1]	
Free Electives		
Select 13 credit hours of the following:		13
AT 0124	Ag Mach Mech	
AT 0274	Agribus Marktng & Entrepreneur [1]	
AT 0394	Golf Course Practicum	
AT 0444	CAD for Landscaping [1]	
AT 0514	Cont Ag Issues	
AT 0544	Horticulture Production	
AT 0664	Golf & Sports Turf Management [1]	
AT 0684	Landscape Design [1]	
AT 0694	Landscape Contracting [1]	
AT 0704	Turfgrass Capstone Project [1]	
AT 0714	Hardscape Materials & Instal [2]	
Total Credits		**64**

[1] Prerequisites: some courses on this checksheet may have pre or corequisites; please consult the University Course Catalog or check with your advisor.

Students must achieve a 2.0 cumulative GPA for all hours attempted (including transfer, advanced placement, and credit by examination). All Agricultural Technology courses will be used in calculation of the GPA.

Graduation Requirements

Each student must complete 64 credit hours, as delineated in the Program Requirements, with a minimum overall GPA and an in-major GPA of 2.0. The in-major GPA calculation will be based on all courses with an AT designator.

Foreign Language Requirement

No requirement.

Agricultural, Leadership, and Community Education

Our Website (http://www.alce.vt.edu)

Overview

The Department of Agricultural, Leadership, and Community Education at Virginia Tech is committed to preparing students for success in professions that apply agricultural content to social settings. We offer a majors in Agricultural and Extension Education and Community Leadership and Development. Our minors include Leadership and Social Change and Teaching and Learning in Agriculture. Our students will experience an interdisciplinary program of study designed to address the growing needs of today's evolving agricultural and food systems. The Leadership and Social Change minor is for students planning to pursue careers in a variety of different fields including non-profit organizations, government governmental and non-governmental agencies, industry, and educational sectors. The minor for Teaching and Learning in Agriculture is a great opportunity to learn more about the practical skills of teaching agriculture to supplement your major. Throughout this minor's curriculum, you will examine educational practices and use them to learn applicable skills for your future career.

Agricultural and Extension Education Major (AEE)

The Agricultural and Extension Education major prepares individuals to excel in careers related to youth education in community programs, middle and high school agricultural education, and adult education.

Community Leadership and Development (CLD)

The Community Leadership and Development major is intended for students interested in bridging community-based education efforts with leadership development in agricultural contexts, including non-profit, government, commodities, and industry/corporate roles.

Degree Requirements

For additional information about both degrees, contact Courtney Collins, Academic Advisor and Program Coordinator, cswanson8@vt.edu, 540-231-3694.

Leadership and Social Change Minor (ILRM)

The Leadership and Social Change minor introduces students to the academic study of leadership and provides them with interdisciplinary skills to solve complex societal issues at the local, national, and international levels. While engaging in the study of leadership, students will also learn about the Social Change Model of Leadership Development created specifically for college students. This model helps students understand themselves (individual values), how to work with others (group values), and how to better serve their communities (society values). In this process, students will not only learn *about* leadership but will also answer the question: leadership *for what*?

The Leadership and Social Change minor requirements may be found by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

For additional information about the minor, contact Dr. Austin Council at (540) 231-8188 or adc@vt.edu.

Teaching and Learning in Agriculture Minor (TLAG)

The minor for Teaching and Learning in Agriculture will capture the interest of individuals interested in learning how to apply practical educational pedagogy in diverse career settings across all areas of

agriculture and life sciences. Completion of the minor will offer students job market opportunities beyond those specifically associated with their major.

The Teaching and Learning in Agriculture minor requirements may be found by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html (https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.registrar.vt.edu%2Fgraduation-multi-brief%2Fchecksheets.html&data=05%7C02%7Cmgreaud%40vt.edu%7Cbf0faeda90f6418c155708dc8729037d%7C6095688410ad40fa863d4f32c1e3a37a%7C0%7C0%7C638533857415601467%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C&sdata=uLFeG1x52ecd7v6SNx6FFDm3TSROgsrk93J%2F8Wo4Vtg%3D&reserved=0).

For more information about the minor, contact Dr. Brett Milliken at (540) 231-1003 or bmilliken@vt.edu (https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fvt-next.courseleaf.com%2Fcourseleaf%2Fbmilliken%40vt.edu&data=05%7C02%7Cmgreaud%40vt.edu%7Cbf0faeda90f6418c155708dc8729037d%7C6095688410ad40fa863d4f32c1e3a37a%7C0%7C0%7C638533857415616227%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C0%7C%7C%7C%7C&sdata=F8%2FPho6iQWjYRU3L2ctR1NHw6VFCX3iryxN1Dmkf8Is%3D&reserved=0).

Satisfactory Progress

Once students enrolled in the AEE or CLD major have attempted 72 hours (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" will consist of:

- GPA of at least 2.0
- at least 24 credits that apply to the Curriculum for Liberal Education, and
- at least 9 semester credits of departmental requirements.

- Agricultural and Extension Education Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/agricultural-leadership-community-education/agricultural-extension-education/)
- Community Leadership and Development Major (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/agricultural-leadership-community-education/community-leadership-development/)

Head: Tracy Rutherford
Professors: L. V. Crowder, E. K. Kaufman, K. L. Niewolny, R. D. Rudd, T. A. Rutherford, and D. M. Westfall-Rudd
Associate Professors: T. G. Archibald, C. R. Friedel, and H. H. Scherer
Assistant Professors: T. A. Drape, R. Nayak, J. Parrella, and H. M. Sunderman
Collegiate Faculty: A. D. Council, K. McCain, D. B. Milliken, and J. H. Walz
Instructor/Lecturer: S. C. Mariger and M. M. Seibel
Adjunct/Affiliate Faculty: S. J. Manchester, D. Odoom, J. Obeng-Baah, and R. J. Rateau
Adjunct Associate Professor: F. Shushok
Emeritus Faculty: S. R. Burke, W. G. Camp, J. R. Crunkilton, and J. H. Hillison

Undergraduate Program Director: D. M. Westfall-Rudd (540) 231-5717; mooredm@vt.edu

Undergraduate Course Descriptions (ALCE)

ALCE 2094 - Introduction to Metal Fabrication (1 credit)
Introduction to metal working tools, equipment/operation and safety practices. Including the fundamentals of Oxy-Acetylene (OA) gas welding, Shielded Metal Arc Welding (SMAW) and Gas Metal Arc Welding (GMAW).
Instructional Contact Hours: (3 Lab, 1 Crd)

ALCE 2294 - Animal Structures and Environment (3 credits)
Functional considerations in facilities development for production agriculture. Concepts of farmstead planning and system development. Techniques for providing safe and efficient animal production environments, especially for confinement facilities.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 2414 - Identity and Inclusion in Agricultural and Life Sciences (3 credits)
Examines histories of persons representing different social identities, statuses, space, place, and traditions in agricultural and life sciences. Explores how differences influence experiences individuals may have in agricultural and life sciences. Apply ethical reasoning practices to recognize and addresses critical issues surrounding inclusion of diverse populations within agricultural and life sciences education and leadership.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2414

ALCE 2484 - Engine and Power Train Technology (3 credits)
Engine and power train technology with an emphasis on the fundamentals of internal combustion engines, electrical systems, power transmission systems and maintenance practices.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALCE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 3004 - Educational Programs in Agricultural and Life Sciences (3 credits)
Offers a foundation for student engagement and exploration of educational programs within agricultural and life sciences. Formal and non-formal learning contexts in local community programs. Opportunities include fieldwork assignments.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3014 - Leadership Effectiveness for Professionals in Agricultural Organizations (3 credits)
Leadership theory and skills required to perform effectively in leadership positions within agricultural organizations and communities. Leadership skills, personal development, teamwork, and social responsibility in agriculture industry.
Prerequisite(s): LDRS 1015 or LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3084 - Agricultural Metal Fabrication (3 credits)
Introduction to metal working tools, equipment, and processes. Fundamentals of hot and cold metal working, plumbing, and welding applications, including inert gas welding processes. Junior standing or consent of instructor is required.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ALCE 3494 - Advanced Welding Technology (1 credit)
Techniques in metal work and welding that include tool maintenance, Oxy-Acetylene (OA), Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), Gas Tungsten Arc Welding (GTAW). Design of welded structures, fundamentals of heat treatment, plastic welding and Plasma Arc Cutting (PAC). Pre: Junior standing.
Instructional Contact Hours: (3 Lab, 1 Crd)

ALCE 3624 - Communicating Ag and Life Sciences in Writing (3 credits)
Communication skills necessary to carry out work with the general public and audiences in the food, agriculture, and natural resources fields. Professional writing for diverse audiences, assessing best written communication practices, and on creation of a portfolio, utilizing multiple platforms of written communication. Pre: Junior standing.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3634 - Communicating Ag and Life Sciences in Speaking (3 credits)
Strategies and techniques for effective oral communication in professions related to food, agriculture, and natural resources. Oral, visual, and interpersonal communication, ethical framing of complex problems, group leadership, and meeting management.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3814 - Life Sciences Communication & Public Engagement (3 credits)
Identifying principles of inclusive and culturally responsive public engagement. Creating life sciences communication strategies and community-centered approaches that maximize public engagement. Evaluating effects of life sciences communication strategies on public engagement.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ALCE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4004 - Teaching Adults in Agriculture (2 credits)
Organizing classes, developing programs of instruction and teaching techniques applicable to out-of-school groups in Agriculture.
Instructional Contact Hours: (2 Lec, 2 Crd)

ALCE 4014 - Introduction to Cooperative Extension (3 credits)
An overview of the Cooperative Extension Service as it applies to non-formal education for citizens and communities. Major areas discussed include history, organization, functional areas, responsibilities of local agents, employment in extension, and educational program planning.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4024 - Managing Agricultural Supervised Occupational Experience Project (2 credits)
Major emphasis will be given to the agricultural teachers responsibility for supervision of the Supervised Occupational Experience Program (SOEP). The course will emphasize the ownership project, the cooperative placement project, maintaining record books, and supervising the SOEP.
Instructional Contact Hours: (2 Lec, 2 Crd)

ALCE 4034 - Methods of Planning Education Programs for Agriculture (3 credits)
Course examines the procedures involved in the development of courses, curriculum, and instructional materials for education programs in agriculture.
Prerequisite(s): ALCE 3004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: EDCT 4034

ALCE 4044 - Agricultural Sciences Seminar (3 credits)
A senior capstone course addressing issues of importance for majors in Agricultural Sciences. The course will emphasize a synthesis of research results from collected data and information on contemporary problems in agriculture and related fields and a sharing of the results. It will emphasize the development of skills in critical analysis. Senior Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4054 - Internship in Coop Extension (1-16 credits)
Off-campus participation experience for those preparing to become extension agents in the Cooperative Extension Service. Variable Credit; 6-16 credits.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)

ALCE 4064 - Ag Mechanical Lab Management (3 credits)
Plan, organize, and manage secondary school mechanics laboratories. Management of the instructional program, facility, equipment, inventory, safety, liability, personnel, material control, and student customer work.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ALCE 4234 - Curriculum for Career and Occupational Education (3 credits)
Provides current and prospective career and occupational education teachers with research bases, resources, and available curricula for teaching content in the respective disciplines. Develops the ability to plan, manage, develop, and evaluate curricula. The prerequisite EDCT 2604 will be waived for Agricultural Education students. Pre: Junior Standing
Prerequisite(s): EDCT 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4244 - Teaching and Training Methods in Agricultural and Life Sciences (3 credits)
Survey of strategies for design, implementation, and evaluation of instruction and training practices in agricultural life sciences. Applications of principles in formal and non-formal educational settings, including schools, extension, and industry. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4254 - Adult Vocational&Technical Ed (3 credits)
Theory, practices, and procedures involved in planning, developing, implementing, managing, and evaluating adult education programs in Vocational and Technical Education. Completion of, or concurrent enrollment in, courses in teaching methods and curriculum required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4304 - Community Education and Development (3 credits)
Comprehensive examination of community education and development. Community/sustainable community development, strategies for mobilizing social change in/with communities. Explore participatory, popular, and community-based education from rural and urban settings. Globalization, sustainability, and social movement discourse with emphasis on agricultural, health, and food system examples. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ALCE 4744 - Methods, Materials and Practices in Instruction (1-6 credits)
Planning, using, evaluating classroom procedures; selection and organization of subject content and materials in vocational and technical education. Maximum credit: 6 Consent required.
Corequisite(s): EDCT 4754
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ALCE 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)

ALCE 4884 - Youth Program Management (3 credits)
Organizational design of educational youth programs such as 4-H and FFA, including administrative planning, human resource development, recruitment, marketing, and budgeting.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCT 4884

ALCE 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ALCE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (LDRS)

LDRS 1414 - Citizen Leadership (3 credits)
Language, theories, concepts, and competencies associated with practicing effective leadership and social change and developing intercultural and global awareness.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 1424 - Citizen Leadership Praxis (3 credits)
Application of foundational knowledge of leadership, intercultural and global awareness, the social change model, and socially responsible leadership concepts toward a service-learning project.
Prerequisite(s): LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

LDRS 2014 - Principles of Peer Leadership (3 credits)
Theories and basic principles associated with being a positive influence on fellow students, identification of contemporary college student issues, leadership skills utilized to motivate peers in teamwork-based scenarios, leadership skills associated with human development, ethics, maintaining community, and conflict in decision making. May be repeated once for a maximum of 6 credits.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

LDRS 2964 - Field Study (1-19 credits)
May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

LDRS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 3104 - The Dynamics of Leadership (3 credits)
This course examines advanced leadership theories and leadership effectiveness in todays organizations.
Prerequisite(s): LDRS 1015 or LDRS 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 3304 - Elements of Team Leadership (3 credits)
Develop effectiveness in leading, delegating, and communicating within a team environment. Emphasis on motivation of team members, emotional intelligence, ethical issues, team member dynamics, team management, and effective team processes.
Prerequisite(s): LDRS 1015 or LDRS 1414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4044 - Leadership Studies Capstone (1 credit)
Culmination of comprehensive knowledge gained about leadership and social change throughout a students undergraduate career. Involves reflection on collegiate leadership experiences and coursework in the leadership and social change minor. Results in student development of an electronic portfolio (i.e., ePortfolio). Pre: Senior standing.
Prerequisite(s): LDRS 1015 or LDRS 1414
Instructional Contact Hours: (1 Lec, 1 Crd)

LDRS 4514 - Skills for Nonprofit Organizational Leaders (3 credits)
Skills essential for leading nonprofit organizations. Nonprofit sector, governance, fundraising, financial administration, managing personnel, media communications, strategic planning, and leadership skills. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

LDRS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4964 - Field Study (1-19 credits)
May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

LDRS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LDRS 4994 - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

LDRS 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Biochemistry

Our Website (http://www.biochem.vt.edu)

Overview

The Bachelor of Science in biochemistry is designed to provide students with a thorough foundation in chemistry and biology and an appreciation of how these sciences are integrated to explore the molecular mechanisms underlying biological processes. The plan of study prepares students for careers in medicine, veterinary medicine, biomedical research, agriculture, industrial biochemistry, or biotechnology. In addition, it provides the background for post-graduate studies in the life sciences or professional studies in medicine, nursing, veterinary medicine, dentistry, pharmacy, and clinical chemistry.

The department offers the undergraduate biochemistry degree in the College of Agriculture and Life Sciences.

Bioinformatics/Genomics

The department supports students' interest in bioinformatics/genomics by providing instruction and laboratory experience in those areas. Students are advised of appropriate supporting courses in computer science that may be used toward a minor in Computer Science.

Satisfactory progress requirements toward the B.S. in Biochemistry can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Degree Requirements

To qualify for a major in biochemistry, the department requires that students maintain a minimum 2.0 grade point average (GPA) for the hours passed in all required biochemistry, biology, and chemistry courses. In addition, the department requires that a student earn a C- or better in all required biochemistry, chemistry, and biology courses.

The plan of study allows time for qualified students to participate in undergraduate research (BCHM 4994 Undergraduate Research). Qualified students are strongly encouraged to initiate research activity prior to their senior year. A minimum GPA of 2.5 is required for enrollment in BCHM 4994 Undergraduate Research. Students participating in undergraduate research are encouraged to present a senior thesis. Students admitted to the Honors College may use undergraduate research credits toward an Honors Laureate Diploma.

Biochemistry majors may participate in the Cooperative Education Program that alternates academic study with employment experience. Additional information pertaining to the CO-OP program is included in the "General Information" section of this catalog. Summer internships with various businesses and governmental agencies are frequently available, particularly to rising seniors.

The minimum number of credits required for the B.S. in Biochemistry is 120.

The department also offers a graduate program leading to the M.S. and Ph.D. The Department of Biochemistry offers a route to earn a Master of Science in the Life Sciences for students currently enrolled in our B.S. program, who earn an accelerated B.S./M.S. degree combination. Twelve credits may be counted toward the requirements for both degrees.

- Biochemistry Major (p. 522)

Head: G. E. Gillaspy
Associate Head: P. Sobrado
Professors: D. R. Dean, G. E. Gillaspy, P. J. Kennelly, T. J. Larson, J. Li, B. Mukhopadhyay, P. Sobrado, Z. Tu, and J. Zhu
Associate Professors: R. F. Helm, M. W. Klemba, and D. Slade
Assistant Professors: K. D. Allen, B. J. Jutras, C. Lahondere, J. Lemkul, C. Vinauger
Professor of Practice: J. Tokuhisa
Research Assistant Professors: K. Phillips and E. Purwanti
Collegiate Professors: K. Hite, and S. Marine
Adjunct Faculty: D. Capelluto, B. Costa, C. Finkielstein, D. Good, J. Mahaney, D. Tholl, C. Thorpe
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Study Abroad Program Director: M.W. Klemba (231-5729) klemba@vt.edu

Undergraduate Course Descriptions (BCHM)

BCHM 1014 - Biochemistry First Year Experience (1 credit)
Academic and career planning for biochemistry majors and students considering biochemistry as a major. Topics discussed: academic success, careers, diversity and inclusion, graduate school, professional health opportunities, library resources, wellness, undergraduate research, internships, study abroad, and service-learning opportunities. Introduction to biochemistry discipline and faculty. Development of a comprehensive academic plan of study and opportunity for self-awareness/reflection.
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 1024 - Introductory Experience in Biochemistry Research Skills (1 credit)
Introduction of foundational knowledge on the central tenets of biochemistry and research skills. Development of critical thinking skills and professional development through networks. Collection, analysis, and interpretation of data. Evaluation of literature, use of citation management programs, and development of scientific writing and presentation skills. Data management, visualization, and ethics in the context of biochemistry. Emphasis on teamwork, literature reading, and scientific communication skills.
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2024 - Concepts of Biochemistry (3 credits)
Short course in fundamentals of the chemistry of living systems. Introduction to major categories of biochemical substances, metabolic pathways, and principles of biochemical information transfer. (No credit for majors).
Prerequisite(s): CHEM 2514 or CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 2114 - Biochemical Calculations (2 credits)
Fundamental mathematical relationships in biochemistry. Calculations central to the investigation of biochemical phenomena including aqueous chemistry, spectrophotometry, enzyme kinetics and thermodynamics. Introduction to the core calculations used in experimental biochemistry and the strategies employed for solving biochemical problems.
Prerequisite(s): CHEM 2535 or CHEM 2565
Instructional Contact Hours: (2 Lec, 2 Crd)

BCHM 2354 - Biochemical Techniques (3 credits)
Fundamental aspects of biochemical laboratory measurements. Properties of biomolecules and methods for their isolation, separation, detection and quantification. Calculations required to provide quantitative biomolecular data. Common instrumentation in biochemical laboratories, their principles of operation, and their roles in biochemical assays and measuring biochemical interactions. Overview of on-line resources for biochemical information.
Prerequisite(s): CHEM 2514 or CHEM 2535 or CHEM 2565
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 2364 - Biochemical Techniques Laboratory (1 credit)
Operation of key equipment found in a biochemistry/molecular biology laboratory (e.g., enzyme kinetics, PCR); analyzes, interpretation and presentation of data acquired in laboratory-based protocols; report of results of experiments; use of laboratory automation for biochemical measurements.
Corequisite(s): BCHM 2354
Instructional Contact Hours: (3 Lab, 1 Crd)

BCHM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BCHM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 3114 - Biochemistry for Biotechnology and the Life Sciences (3 credits)
Survey presentation of the basic principles of biochemistry as they apply to biotechnology. Topics covered include protein structure, enzymology, cellular organization, and biochemical regulation. Special emphasis will be given to gene structure, transcription, and translation, cellular organization, and cloning, sequencing, modification and expression of recombinant DNA. Examples will be given of agricultural/medical/industrial applications of cellular and molecular biochemical knowledge. Non-majors only.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 3634 - Analysis of Biochemical Literature (3 credits)
Analysis of primary scientific literature using recently published biochemical research articles. Application of the CREATE model (Consider, Read, Elucidate and generate a hypothesis, Analyze and interpret the data, and Think of next Experiment) as a conceptual framework. Evaluation of article data, limitations and broader impacts. Impact of scientific philosophy, experimental design, and peer review in scientific research and publishing. Pre: Junior standing.
Prerequisite(s): (BIOL 2134 or BIOL 2604) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

BCHM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4054 - Genomics (3 credits)
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized.
Prerequisite(s): BCHM 3114 or BCHM 4116 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 4054

BCHM 4074 - Career Orientation (1 credit)
Examination of various career opportunities for biochemists in industry, academia, medicine and related health sciences. Introduction to resources for locating career opportunities, resume preparation and interview skills. Restricted to biochemistry majors. Junior standing required. I
Corequisite(s): BCHM 4115
Instructional Contact Hours: (1 Lec, 1 Crd)

BCHM 4115 - General Biochemistry (4 credits)
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115).
Prerequisite(s): (CHEM 2536 or CHEM 2566) and (BCHM 2114 or CHEM 2154)
Instructional Contact Hours: (4 Lec, 4 Crd)

BCHM 4116 - General Biochemistry (3 credits)
Metabolism and chemistry of carbohydrates, proteins, lipids, and nucleic acids with emphasis on interactions and comparative aspects of microbial, plant, and animal forms. For students in the biochemistry curriculum and other students interested in a foundation course. (Students are required to have at least a C- in both CHEM 2535 and 2536 to be admitted to BCHM 4115). I,II
Prerequisite(s): BCHM 4115
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4124 - Laboratory Problems in Biochemistry and Molecular Biology (6 credits)
Presentation of major analytical techniques of importance to biochemistry and molecular biology, including spectrophotometry, electrophoresis, chromatography. Lab study of selected principles and methods used in biochemistry and molecular biology.
Prerequisite(s): BCHM 4115 and (CHEM 2114 and CHEM 2124) or (CHEM 3114 and CHEM 3124)
Corequisite(s): BCHM 4116
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

BCHM 4354 - Biochemical Communication (3 credits)
Exploration of how chemical signals are produced, transported, and influence microbes (Bacterial and unicellular organism (chemotaxis), plants, and animals (olfactory neuroethology). Applications to cell biology, neurobiology, and ecology. Analysis of the interaction between biochemical communication systems and health (diseases). Management, statistical analysis, and interpretation of large datasets related to biochemical communication, using computational approaches.
Prerequisite(s): (BCHM 3114 or BCHM 4115) and (STAT 2004 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4554 - Biophysics for Biochemistry (3 credits)
Thermodynamics, quantum mechanics, and statistical mechanics in biological systems, with emphasis on theoretical understanding of experimental biophysical methods. Fundamental concepts in protein and nucleic acid folding, dynamics from bond vibrations to kinetics and diffusion, molecular orbital theory, protein-ligand interactions and associated molecular visualization tools. Computational modeling, calculations, and simulation using both quantum and classical mechanics.
Prerequisite(s): BCHM 3114 or BCHM 4115
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4784 - Applications in Molecular Life Science (3 credits)
Synthesis and application of biochemistry, cell biology, genetics, genomics, physiology, immunology concepts and techniques to address medical and agricultural problems. Gene characterization and manipulation, protein-based drugs, diagnostics, vaccines, transgenic plants/animals. Analysis, critique, application of research in molecular life science.
Prerequisite(s): (BCHM 3114 and BCHM 3124 and BIOL 3774 and BIOL 4774) or (BCHM 4116 and BCHM 4124)
Instructional Contact Hours: (3 Lec, 3 Crd)

BCHM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BCHM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BCHM 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Biochemistry Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BCHM 1014	Biochemistry First Year Experience	1
BCHM 2354	Biochemical Techniques	3
BCHM 2364	Biochemical Techniques Laboratory	1
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
BCHM 4124	Laboratory Problems in Biochemistry and Molecular Biology	6
BIOL 2004	Genetics	3
Subtotal		21
Major Requirements		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	2
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry	3
CHEM 2536	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2546	Organic Chemistry Laboratory	1
MATH 1025	Elementary Calculus	3
MATH 1026	Elementary Calculus	3

PHYS 2205	General Physics	3
PHYS 2206	General Physics	3
PHYS 2215	General Physics Laboratory	1
PHYS 2216	General Physics Laboratory	1
STAT 3615	Biological Statistics	3
Select two of the following:		6-7
BCHM 3634	Analysis of Biochemical Literature	
BCHM 4054	Genomics	
BCHM 4354	Biochemical Communication	
BCHM 4554	Biophysics for Biochemistry	
BCHM 4784	Applications in Molecular Life Science	
BCHM 5024	Computational Biochemistry for Bioinformatics [2]	
BCHM 5224	Protein Structure and Function [2]	
BIOL 4624	Microbial Genetics	
BIOL 4884	Cell Biology	
CHEM 4615	Physical Chemistry for the Life Sciences	
CHEM 4616	Physical Chemistry for the Life Sciences	
PPWS 4114	Microbial Forensics and Biosecurity	
SYSB 3035	Genomics and Bioinformatics	
Subtotal		52-53
Free Electives		
Select remaining credit hours of free electives		17
Subtotal		17
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) fulfilled by completing BIOL 1105 and BIOL 1106		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) fulfilled by completing MATH 1025 and MATH 1026		
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) fulfilled by completing STAT 3615		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [1]		3
Subtotal		30
Total Credits		**120-121**

[1] Concept 7 course may also be used to fulfill part of Concept 2 or Concept 3 requirement.

[2] Students in their senior year with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department with the permission of the course instructor and the department head.

Satisfactory Progress Toward Degree

1. After having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination and course withdrawal hours), students must have completed at least 12 semester credits of the Pathways to General Education.
2. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination and course withdrawal hours), students must have completed at least 24 semester credits of the Pathways to General Education.
3. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination and course withdrawal hours), students:
   a. Must have an in-major grade point average of 2.0 or greater; and
   b. Must have completed: BCHM 2354 Biochemical Techniques,BCHM 2364 Biochemical Techniques LaboratoryBIOL 1105 Principles of Biology-BIOL 1106 Principles of Biology; BIOL 1115 Principles of Biology Laboratory-BIOL 1116 Principles of Biology Laboratory; BIOL 2004 Genetics; CHEM 1035 General Chemistry-CHEM 1036 General Chemistry; CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory; CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry; CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory; PHYS 2205 General Physics-PHYS 2206 General Physics; PHYS 2215 General Physics Laboratory-PHYS 2216 General Physics Laboratory.

Graduation Requirements

Credit Hours and GPA Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater. **The following courses are used to calculate the in-major GPA (students must earn a grade of C- or better in each of these courses or their approved substitutions):**

Code	Title	Credits
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
BCHM 4124	Laboratory Problems in Biochemistry and Molecular Biology	6
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1

BIOL 2004	Genetics	3
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	1-2
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry	3
BCHM 2354	Biochemical Techniques	3
BCHM 2364	Biochemical Techniques Laboratory	1
CHEM 2536	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2546	Organic Chemistry Laboratory	1
CHEM 4615	Physical Chemistry for the Life Sciences	3
CHEM 4616	Physical Chemistry for the Life Sciences	3

Pathways to General Education Requirements

Pathways to General Education requirements and approved courses are available online: http://www.pathways.prov.vt.edu/content/pathways_prov_vt_edu/en/about/course-catalog.html

Prerequisites

This checksheet contains no hidden prerequisites, although some courses listed are prerequisites for other courses.

Acceptable Substitutions

Approved Course Substitutions

- For CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors
- For CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab
- For CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry
- For ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing: COMM 1015 Communication Skills-COMM 1016 Communication Skills
- For ENGL 1106 First-Year Writing: ENGL 1204H
- For STAT 3615 Biological Statistics: STAT 3005 Statistical Methods
- For CHEM 4615 Physical Chemistry for the Life Sciences-CHEM 4616 Physical Chemistry for the Life Sciences: CHEM 3615 Physical Chemistry-CHEM 3616 Physical Chemistry
- For MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable
- For PHYS 2205 General Physics-PHYS 2206 General Physics and PHYS 2215 General Physics Laboratory-PHYS 2216 General Physics Laboratory: PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics

Foreign Language Requirement

Students who did not successfully complete at least two units of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Biological Systems Engineering

Our Website (http://www.bse.vt.edu)

Overview

The mission of the Department of Biological Systems Engineering (BSE) is to develop and disseminate engineering knowledge and practices that protect natural resources and improve sustainable production, processing, and utilization of biological materials.

The teaching program in BSE offers engineering B.S., M.S., and Ph.D. programs for students enrolled in the College of Engineering and service courses for students enrolled in the College of Agriculture and Life Sciences and other colleges. The degree programs in BSE are administered by the College of Engineering; therefore, the curriculum and courses offered for the B.S. in biological systems engineering are listed in the College of Engineering section of this catalog. Students interested in pursuing an undergraduate degree program in Biological Systems Engineering must first be admitted to the College of Engineering.

Service courses designed to meet the needs of students enrolled in different programs in CALS are listed in the following section. These courses generally are not taken to meet engineering degree requirements except as free electives.

Department Head: D. R. Edwards
Associate Head for Undergraduate Studies: D. T. Scott
Graduate Program Director: C. W. Hession
H.E. and Elizabeth F. Alphin Professor: Z. M. Easton
Elizabeth and James E Turner Jr Faculty Fellows: L.-A. H. Krometis and C. Zhang
Professors: J. R. Barone, B. L. Benham, Z. M. Easton, D. R. Edwards, W. C. Hession, L.-A. H. Krometis, D.J. Sample, D. T. Scott, J.S. Wayne, and C. Zhang
Associate Professors: J. Arogo Ogejo, F. Batarseh, J. A. Czuba, R. S. Senger, J. E. Shortridge, V. R. Sridhar, T. M. Thompson, and Z. Wang
Assistant Professors: A. Chandel, J. Chen, A. Duraj-Thatte, W. Sun, and R. C. Wright
Academic Advisor: P. Baker

Undergraduate Course Descriptions (BSE)

BSE 1004 - Engineering Biological Systems for the Global Good (1 credit)
Survey of global societal and technological issues that engage biological systems engineers in the areas of health, environment, food and energy. Application of systems-level approaches to meet engineering challenges that intersect with crucial societal issues, including sustainability and equity. Evaluation of key factors that affect the design, communication, and public acceptance of engineered solutions. Analysis of cultural intelligence, with a specific focus on personality and problem solving styles amongst individuals and teams and productive conflict resolution.
Instructional Contact Hours: (1 Lec, 1 Crd)

BSE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2004 - Introduction to Biological Systems Engineering (3 credits)
Introduction to the fundamental concepts of Biological Systems Engineering, including statistics and material and energy balances, through applications in protein separation, hydrology, sediment/nutrient transport, and microbial metabolism. Engineering design process. Engineering problem-solving tools and techniques. Resolving ethical dilemmas. Development of oral and written communication skills; introduction to job searching resources; strategies for career development, and the importance of teamwork and ethics in Biological Systems Engineering.
Prerequisite(s): ENGE 1215 or ENGE 1414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2304 - Landscape Measurements and Modeling (3 credits)
Introduction to land surveying, computer-aided design, and drafting for land and water resources engineering. Representation of features in two and three dimensions for documentation and visualization of watershed engineering projects. Create plans, cross sections, detail drawings, and three dimensional visualizations using computer-aided design and drafting tools.
Prerequisite(s): MATH 1206 or MATH 1226
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3144 - Engineering Analysis for Biological Systems using Numerical Methods (2 credits)
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. Course requirements may be satisfied by taking MATH 2214 prior to or concurrent with course.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (2 Lec, 2 Crd)

BSE 3154 - Thermodynamics of Biological Systems (3 credits)
Description of biological, chemical and mechanical mechanisms of energy storage and conversion to work. Derivation and use of the first and second laws of thermodynamics (energy and entropy) to analyze processes found in biotechnology, ecological engineering, and living systems. Analysis of thermodynamic cycles and their relevance to biological systems. Introduction of Gibbs energy, equilibrium at specified pH, and calorimetry of biological reactions.
Prerequisite(s): CHEM 1036 and PHYS 2305 and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3324 - Small Watershed Hydrology (3 credits)
Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis.
Prerequisite(s): PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3334 - Nonpoint Source Pollution Assessment and Control (3 credits)
Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control.
Prerequisite(s): BSE 3324
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 3504 - Transport Processes in Biological Systems (3 credits)
Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions.
Prerequisite(s): BSE 3154 and ESM 3024 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3524 - Unit Operations in Biological Systems Engineering (3 credits)
Description of unit operations for processing biological materials including evaporation, drying, gas-liquid separations, adsorption, membrane separation, and mechanical separation.
Prerequisite(s): BSE 3154 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3534 - Bioprocess Engineering (3 credits)
Engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Metabolic pathways leading to products, enzyme kinetics, cell growth kinetics, and analysis of bioreactors and fermenters.
Prerequisite(s): BSE 3154
Corequisite(s): BIOL 2604, BSE 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4125 - Comprehensive Design Project (2 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126: Complete a comprehensive design project using the team approach, test approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 3334 or BSE 3524
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BSE 4126 - Comprehensive Design Project (3 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126 Complete a comprehensive design project using the team approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 4125
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BSE 4204 - Instrumentation for Biological Systems (3 credits)
Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles. Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts.
Prerequisite(s): PHYS 2306 and ESM 3024
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

BSE 4224 - Field Methods in Hydrology (3 credits)
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, dataloggers, water quality sondes. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control.
Prerequisite(s): BSE 3324 or FREC 3104 or WATR 3104 or CEE 3314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4304 - Introduction to Watershed Modeling (3 credits)
Fundamental modeling principles used to quantifywatershed hydrology, energy budgets,and associated ecosystem functions, such asplant dynamics and biogeochemical processes, at scales ranging from soil poresto watersheds. Code development and model integration to simulate watershed hydrologyandnutrient and sediment transport. Model calibration and performance assessment. Data discovery, acquisition, and processing of data relevant to hydrologic/watershed modeling.
Prerequisite(s): BSE 3334
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4324 - Applied Fluvial Geomorphology (3 credits)
Introduction to landscape evolution. Influence of geology and climate on stream form and processes. Fundamental river mechanics and sediment transport. Stream surveying and classification. River system response to changes in hydrology and sediment supply. Interactions between ecosystems and fluvial systems. Human impacts on stream systems.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4344 - Geographic Information Systems for Engineers (3 credits)
Conceptual, technical, and operational aspects of geographic information systems as a tool for storage, analysis, and presentation of spatial information. Focus on engineering applications in resource management, site selection, and network analysis. Laboratory work and senior standing required.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4394 - Water Supply and Sanitation in Developing Countries (3 credits)
Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: Junior or Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4524 - Biological Process Plant Design (3 credits)
Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirements, economic analysis. Process control and instrumentation of bioprocessing plants.
Prerequisite(s): BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4534 - Bioprocess Engineering Lab (1 credit)
Unit operations commonly used in processing biological materials, including filtration, heat transfer, ultrafiltration, crystallization, and protein expression by fermentation, purification by chromatography, and characterization by gel electrophoresis.
Prerequisite(s): BSE 3524 and BSE 3534
Instructional Contact Hours: (3 Lab, 1 Crd)

BSE 4544 - Protein Separation Engineering (3 credits)
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software.
Prerequisite(s): BSE 3504 or CHE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4544

BSE 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4554, HORT 4554, LAR 4554, SPIA 4554

BSE 4564 - Metabolic Engineering (3 credits)
Engineering concepts for analyzing, designing, and modifying metabolic pathways to convert raw materials to food, pharmaceuticals, fuels and chemicals. Cell metabolism, pathway design, bioenergetics, regulatory mechanisms, metabolic modeling, and genetic tools.
Prerequisite(s): BSE 3534 or BCHM 4115 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4604 - Food Process Engineering (3 credits)
Analysis and design of food processing operations including thermal pasteurization and sterilization, freezing, extrusion, texturization, and mechanical separation.
Prerequisite(s): BSE 3504 and BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Entomology

Our Website (http://www.ento.vt.edu)

Overview

Entomology is both a basic and an applied science which deals with the study of insects and their effects upon the health, economy, and welfare of humankind.

The department offers graduate programs leading to the MSLFS (thesis or non-thesis) and PhD (see Graduate Catalog). The departmental teaching, research, and extension programs are closely coordinated with those of other departments.

Insects are important as agricultural, health, and aesthetic pests and as beneficial organisms which serve as pollinators, biological control agents for pest populations, and as components of natural ecosystems. While entomologists have only scratched the surface in the study of insects and related arthropods, their research has yielded great benefits to humankind. Examples include reductions in human diseases transmitted by insects and the leadership shown by entomologists in the development of integrated pest management principles and procedures.

Head: T. J. Kring
Professors: S. A. Entrekin, T. J. Kring, T. P. Kuhar, D. M. Miller, D. G. Pfeiffer, A. Rashed, S. M. Salom, and I. V. Sharakhov
Associate Professors: J. A. Auguste, W. Booth, M. J. Couvillon, G. Eastwood, A. D. Gross, P. Marek, K. B. Rice, S. L. Paulson, and M. V. Sharakhova
Assistant Professors: A. Del Pozo-Valdivia, R. Schürch, and C. S. Yang
Collegiate Assistant Professor: J. M. Wilson

Undergraduate Course Descriptions (ENT)

ENT 2004 - Insects and Human Society (3 credits)
Past, present, and future role of insects in human society. Insect biology, diversity, and identification of common insects and other arthropods. Effects of insects on disease transmission, global food security, and human health. Management of pests of plants, animals, insects as food, and its effects on environmental pollution. Critique popular science communication and its effect on public policy. Human perceptions of insect conflicts, benefits of insects, and arthropod conservation across the world.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 2254 - Bees and Beekeeping (2 credits)
An introduction to honey bee biology, the social organization of the honey bee colony and to modern apiculture, including the use of bees for pollination. Topics on beekeeping include equipment, how to get started, and colony management practices. II
Instructional Contact Hours: (2 Lec, 2 Crd)

ENT 2264 - Bees and Beekeeping Laboratory (1 credit)
A laboratory course which examines the principles and practices of modern apiculture as they relate to honey bee biology. An emphasis is placed on students gaining practical field experience in modern management techniques. II
Corequisite(s): ENT 2254
Instructional Contact Hours: (3 Lab, 1 Crd)

ENT 2804 - Bees: Biology, Diversity, and Sustainability (3 credits)
Foundational introduction to bees. Behavior, communication, and social organization of honey bees; diversity and use of alternative (non honey bee) pollinators; scientific inquiry in ecosystem services management; and current global challenges to and sustainable solutions for pollination in the modern-day agricultural landscape.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 3014 - Insect Biology (2 credits)
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: BIOL 3014

ENT 3024 - Insect Biology Laboratory (2 credits)
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required. I
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): ENT 3014
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: BIOL 3024

ENT 3254 - Medical and Veterinary Entomology (3 credits)
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 3254

ENT 3264 - Medical and Veterinary Entomology Laboratory (1 credit)
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group.
Prerequisite(s): (BIOL 1105 and BIOL 1106) or (BIOL 1005 and BIOL 1006) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): ENT 3254
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: BIOL 3264

ENT 4254 - Insect Pest Management (3 credits)
Principles of insect pest management with application to the major insect pests found in Virginia. Pest management involves the utilization of all effective control practices in a program which is ecologically and economically efficient. This course is intended for all students with an interest in efficient agricultural production and in reducing losses to our most diverse competitor. One year of General Biology required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ENT 4264 - Pesticide Usage (3 credits)
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: PPWS 4264

ENT 4354 - Aquatic Entomology (4 credits)
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organism in aquatic ecology, pollution monitoring, and natural resource management.
Prerequisite(s): (BIOL 1005 and BIOL 1006) and (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106 and BIOL 1115 and BIOL 1116)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4354

ENT 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4484, FIW 4484

ENT 4624 - Animal and Plant Biosafety and Biosecurity (3 credits)
A One Health approach to the concept of biosafety and biosecurity. Principles, tools and techniques of disease detection, early warning, and containment of animal and plant pathogens. Regulatory agencies and guidelines that work to protect human, animal, plant, and environmental health and prevent economic and public health disasters. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Exploring Life Sciences

Overview

The College of Agriculture and Life Sciences offers a program for students who are exploring their major during the first two years at Virginia Tech. This flexibility allows students to explore career opportunities in different fields, to meet faculty in different departments, and to investigate the wide-range of majors and options within the college as well as in the university. Working closely with an advisor in the Office of Academic Programs, students will take foundation courses required of most majors (biological sciences, math, English and chemistry) in the college and be encouraged to take exploratory courses in different departments to sharpen their career focus.

Advisor: Jennifer Carr
(540) 231-8127
jjc@vt.edu

Food Science and Technology

Our Website (http://www.fst.vt.edu)

Overview

Food science benefits consumers every day with healthier diets, better tasting affordable foods, and increased food safety. In the Department of Food Science and Technology, you really do get to play with your food! Food Science is an exciting area that applies a blend of basic sciences such as biology, chemistry and physics with microbiology, biochemistry, mathematics and engineering to improve the taste, nutrition and value of the world's food supply. The Food Science and Technology curriculum includes hands-on experiences that supports classroom instruction with practical applications and creative opportunities for product development.

Demand for Food Science and Technology graduates has never been greater. Practically 100% of Virginia Tech's Food Science and Technology graduates have jobs in product development, research, sales and marketing, quality assurance, production management, analytical and technical services and regulatory affairs at graduation. Food processing is the largest industry in the United States. This industry employs nearly 2 million people and accounts for more than 16 percent of the country's gross national product. In a recent survey of U.S. Food Science programs, Virginia Tech ranked 6th nationally in placing Food Science B.S. graduates into graduate or professional schools.

The Virginia Tech Department of Food Science and Technology is the only food science department in Virginia. The program is recognized by the national Institute of Food Technologists (IFT) as having curricula and options that meet the "IFT Undergraduate Education Standards for Degrees in Food Science." Students enrolled in these programs are eligible to apply for IFT Scholarships. The Virginia Tech Food Science Club is a student chapter of the national IFT organization and houses the Product Development and College Bowl teams that permits students to meet professionals in the food industry, develop leadership skills and enhance their educational experience. Students have excellent opportunities for internships as an additional way to explore different facets of the food industry.

The Food Science and Technology building is home to a 5,000 square-foot processing pilot plant, a fully-equipped research winery, a cutting-edge high-pressure processing area as well as laboratories modernly equipped for chemical, physical and microbiological analysis of foods. Due to the department's success and growth we expanded to the Human and Agricultural Biosciences Building (HABB1) and the Integrated Life Sciences Building in the VT Corporate Research Park. HABB1 is, located across the street from our present building provides the department with additional laboratories, pilot plants, taste panel and

food preparation facilities, conference rooms, graduate student research spaces and faculty and staff offices. In the Department of Food Science and Technology you may receive a Bachelor of Science in one of four options: Food Business, Food and Health, Science or Food and Beverage Fermentation.

The Department also offers a minor, as well as a double-major option in Food Science and Technology to students in all other colleges of the university. Students completing the Science or Food & Health option requirements will also be prepared for graduate schools and professional schools of pharmacy medicine, dentistry and veterinary medicine. Food Science and Technology students have the opportunity to participate in stimulating undergraduate research projects and internships.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Food Science and Technology Major with Food and Beverage Fermentation Option (p. 531)
- Food Science and Technology Major with Food and Health Option (p. 532)
- Food Science and Technology Major with Food Business Option (p. 533)
- Food Science and Technology Major with Science Option (p. 535)

Head: R. R. Boyer
Professors: R. R. Boyer, J. D. Eifert, S.F. O'Keefe, M.A. Ponder, S.S. Sumner,
Associate Professors: D. D. Kuhn, A.C. Stewart, L. Strawn, H.Huang, J. Lahne
Assistant Professors: Y. Cheng, R. Cheng, D. Cladis, A. Hamilton, Y. Yin
Assistant Professor of Practice and Undergraduate Program Director: H. Bruce
Graduate Program Director: J. D. Eifert
Collegiate Faculty: K. Hurley
Undergraduate Laboratory Manager: J. A. Eifert
Research Assistant Professor: R. Carneiro
Research and Extension Faculty: B. Driver, K. Parraga-Estrada, A. Sandbrook, L. Schonberger, B. Wiersema, M. Wright
Research Associates: M. Ac-Pangan, Q. Jin, X. Liu, X. Su
Adjunct Faculty: T. Lorca, D. Weller

Research Staff: S. Hayes, H. Wang, K. Waterman
Communication: A. Hood
Administrative Staff: J. Boling, D. Eastwood, T. Pauley, T. Rakestraw

Undergraduate Course Descriptions (FST)

FST 2004 - Exploring Food Science Careers (1 credit)
Food science specialization areas and career opportunities. Experiential learning opportunities developed through bridge experience platform. Introduction to research, internship, study abroad and individualized learning. Career preparation, job and internship search strategies.
Instructional Contact Hours: (1 Lec, 1 Crd)

FST 2014 - Introduction to Food Science (2 credits)
Fundamentals for food science and technology. Integration of basic principles of food safety, human nutrition, food spoilage, and sensory evaluation with the appropriate technology of food preservation and processing.
Instructional Contact Hours: (2 Lec, 2 Crd)

FST 2024 - From Raw to Burnt: Exploring Science and Society through Foods (3 credits)
Food as a method of studying scientific principles and development of society, including acquiring, preserving, processing and consuming foods. Integration of chemistry, biology and physics of grains; salt and spices; meat, poultry, and fish; dairy and eggs; fruits and vegetables; and fat and oils, with the advancements in and the cost to human civilization from historical and ethical perspectives of food production. Scientific principles demonstrated in food preparation.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2044, PSCI 2044

FST 2244 - Topics in Food Science and Technology (1-3 credits)
Variable topics in food science and technology such as emerging trends, challenges and regulatory policy. Qualitatively and quantitatively explore relevant and timely issues facing food systems. May be repeated for a maximum of six credits with different topics. Pre: Sophomore standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

FST 2424 - Introduction to Food and Beverage Fermentation (3 credits)
Principles, processes, and applications of fermentation in the context of food and beverage production. Explores various fermentation techniques, the chemical processes and microbiology involved, and the role of fermentation in enhancing flavor, texture, preservation, and nutritional value. Hands-on experience through workshops and sensory evaluation.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 2544 - Functional Foods for Health (3 credits)
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2544

FST 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 3024 - Principles of Sensory Evaluation (3 credits)
Principles of sensory evaluation including theory, sensory physiology and psychology, experimental methods, applications, and statistical analysis.
Prerequisite(s): STAT 3005 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 3114 - Wines and Vines (3 credits)
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 3114

FST 3124 - Brewing Science and Technology (3 credits)
Study of chemical reactions important in brewing of beer and hard cider. Effects of variations in malting, mashing, and other processing steps on characteristics and quality of beer; fruit sugar, acid and fermentation impacts on cider composition and quality. Investigation of reactions that cause flavor deterioration.
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 3214 - Principles of Meat Science (3 credits)
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations.
Prerequisite(s): ALS 2304 and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 3214

FST 3514 - Food Analysis (4 credits)
Data analysis, sampling techniques, theory and practice of chemical and physical methods of food analysis for determination of food composition; application of analytical methods of quality control and food laws and regulations.
Prerequisite(s): (STAT 3615 or BIT 2405) and (CHEM 2535 or CHEM 2514)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FST 3604 - Food Microbiology (4 credits)
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Method to enumerate, identify, and characterize microorganisms in foods.
Prerequisite(s): BIOL 2604 and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 3604

FST 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

FST 4004 - Food Science Experiential Learning Reflection (1 credit)
Reflection of skills and knowledge developed during food science experiential learning process. Analyze curriculum. Development of communication skills to reflect and evaluate their experience.
Instructional Contact Hours: (1 Lec, 1 Crd)

FST 4014 - Concepts of Food Product Development (3 credits)
Application to the food industry of principles and standard practices of research and product development; functionality of food ingredients; students will work in teams to design and develop a new food product.
Prerequisite(s): FST 3604
Corequisite(s): FST 4405, FST 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4104 - Applied Brewing Science and Engineering (3 credits)
Chemistry, biochemistry, and engineering aspects of brewing operations in the production of beer. Barley, malting, hops, brewing operations, fermentation chemistry, yeast characteristics and finishing operations examined. Calculations of raw materials, brewing and fermentation schedules, and final specifications conducted. Laboratory exercises focused on brewing, brewery engineering, and analysis of intermediate and final products.
Prerequisite(s): FST 3604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FST 4204 - Advanced Topics in Food Science and Technology (1-3 credits)
Variable advanced topics in food science and technology such as emerging trends, challenges and regulatory policy. Qualitative and quantitative exploration of relevant and timely issues facing food systems. May be repeated for a maximum of six credits with different topics. Pre: Junior standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

FST 4304 - Food Processing (3 credits)
Basic principles of unit operations. Heat and mass transfer. Equipment in commercially important food processing applications. Raw food materials and packaging. Processing methods to ensure food safety and quality.
Prerequisite(s): BIOL 2604 and BIOL 2614 and (MATH 1025 or MATH 1524)
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4314 - Food Processing Laboratory (1 credit)
Safety and good manufacturing practice of food processing. Operation of key equipment found in the food industry. Collection, analysis and interpretation of data acquired in lab exercises. Documentation and reporting of findings.
Corequisite(s): 4304 or BSE 4604.
Instructional Contact Hours: (1 Lab, 1 Crd)

FST 4414 - Fermentation Process Technology and Instrumentation (2 credits)
Process design considerations for food and beverage fermentations, and other industrial fermentation processes. Critical process parameters, and instrumentation for fermentation process monitoring. Hands-on process instrumentation for fermentation.
Prerequisite(s): FST 4504 or FST 3604
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

FST 4504 - Food Chemistry (3 credits)
Overview of the chemical and functional properties of food components including major (water, proteins, carbohydrates, enzymes and lipids) and minor (vitamins, minerals, flavors, pigments) constituents; chemical, biochemical reactions and physical phenomena occuring during food handling, processing, and storage; their impact on the nutritional and sensorial quality of food.
Prerequisite(s): BCHM 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4524 - Food Safety and Quality Assurance (3 credits)
Monitoring safety and quality of food as well as compliance with government regulations. Description of regulatory agencies and food regulations. Development of specifications, food standards and safety critical control points. Systems to assure a safe and quality product, including acceptance sampling and statistical process control.
Prerequisite(s): FST 3604 and FST 4304
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4534 - Food Chemistry Lab (1 credit)
Investigation of functional properties of proteins, carbohydrates, and lipids in processed foods including effect of environmental conditions; solubility, foaming ability and textural properties of proteins, carbohydrate crystallization, ability of polysaccharides to form gels and pastes, lipid absorption and tenderization, characterization of a natural-occurring enzyme.
Corequisite(s): FST 4504
Instructional Contact Hours: (3 Lab, 1 Crd)

FST 4544 - Distillation and Fermentation Analysis (3 credits)
Sampling and analysis of pre-and post-fermentation foods and beverages to determine process termination, efficiency, and formation of desired and non-desired products. Laws and regulations pertaining to fermented foods and beverages. Distillation as an analytical tool and as a production method for food/beverage products.
Prerequisite(s): FST 4504 and FST 3514
Corequisite(s): FST 4104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FST 4634 - Epidemiology Foodborne Disease (3 credits)
Overview of causes, transmission, and epidemiology of major environmental, food, and water borne diseases. Outbreak and sporadic detection, source tracking and control of pathogens. Overview of the impact of foodborne outbreaks on regulatory activities at the national and international level. Corequisite: Enrollment in either FST 3604 or BIOL 4674.
Corequisite(s): BIOL 4674, FST 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

FST 4644 - Fermentation Microbiology (2 credits)
Physiology, biochemistry, and genetics of microorganisms used for production of food ingredients, fermented foods, and beverages. How microorganisms are used in fermentation and the effects of processing and manufacturing conditions on production of fermented foods.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 2 Crd)

FST 4654 - Food and Beverage Fermentation (2 credits)
Introduction to the broad range of fermented foods and beverages. Defining quality parameters of fermented foods and beverages. In-depth examination of the processing methods and equipment employed in commercial-scale production of fermented foods and beverages. Historical, cultural, sensory, and nutritional attributes of fermented foods and beverages. Course requirements may be satisfied by taking FST 3604 or FST 4504 prior to or concurrent with course.
Prerequisite(s): FST 4504 or FST 3604
Corequisite(s): FST 4644
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

FST 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FST 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Food Science and Technology Major with Food and Beverage Fermentation Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
BCHM 2024	Concepts of Biochemistry	3
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	2
FST 2004	Exploring Food Science Careers	1
FST 3514	Food Analysis	4
FST/BIOL 3604	Food Microbiology	4
FST 3900	Bridge Experience	0
FST 4004	Food Science Experiential Learning Reflection	1
FST 4014	Concepts of Food Product Development	3
FST 4304	Food Processing	3
FST 4314	Food Processing Laboratory	1
FST 4504	Food Chemistry	3
FST 4534	Food Chemistry Lab	1
FST 4524	Food Safety and Quality Assurance	3
Subtotal		39
Option Required Courses		
FST 3024	Principles of Sensory Evaluation	3
FST 3124	Brewing Science and Technology	3
FST 4104	Applied Brewing Science and Engineering	3
FST 4544	Distillation and Fermentation Analysis	3
PHYS 2205	General Physics	3
Select one of the following:		3-6
CHEM 2535 & CHEM 2536	Organic Chemistry and Organic Chemistry	
CHEM 2514	Survey of Organic Chemistry	
Subtotal		18-21
Restricted Electives		
Select 10-13 credit hours of the following:		10-13
CHEM 2545 & CHEM 2546	Organic Chemistry Laboratory and Organic Chemistry Laboratory	
FST 2014	Introduction to Food Science	
FST 2244	Topics in Food Science and Technology [1]	
FST/HNFE 2544	Functional Foods for Health	
FST/HORT 3114	Wines and Vines	
FST 4204	Advanced Topics in Food Science and Technology [1]	
FST 4634	Epidemiology Foodborne Disease	

FST 4644	Fermentation Microbiology	
FST 4654	Food and Beverage Fermentation	
FST 4974	Independent Study [1]	
FST 4994	Undergraduate Research [1]	
PHYS 2206	General Physics	
Study Abroad (As approved by department) [1]		
Free Electives (Please note students may need to take more or less free electives to reach the 120 required credit hours)		
Select remaining credits of free electives		6
Subtotal		16-19
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) and Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States [2]		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120-126**

[1] Credits vary depending on course, maximum of three credits allowed for each item.

[2] Pathways 7 may be completed with another Pathways requirement.

Eligibility for Continued Enrollment

1. After having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have passed at least 12 semester credits of Curriculum for Liberal Education requirements.
2. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must:
   a. have passed at least 24 semester credits of Curriculum for Liberal Education requirements.
   b. have passed 9 semester credits in the Food and Beverage Fermentation Option requirements.

Graduation Requirements

1. A minimum of 120 credit hours are required for graduation.
2. A minimum 2.0 overall GPA is required for graduation.
3. A minimum 2.0 in-major GPA is required for graduation (only FST courses will be used for in-major GPA calculation).
4. This check sheet contains no hidden prerequisites. Please refer to the Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign languages courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credits of foreign language have been earned. These credits do not count toward graduation.

Food Science and Technology Major with Food and Health Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
BCHM 2024	Concepts of Biochemistry	3
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	2
FST 2004	Exploring Food Science Careers	1
FST 3514	Food Analysis	4
FST/BIOL 3604	Food Microbiology	4
FST 3900	Bridge Experience	0
FST 4004	Food Science Experiential Learning Reflection	1
FST 4014	Concepts of Food Product Development	3
FST 4304	Food Processing	3
FST 4314	Food Processing Laboratory	1
FST 4504	Food Chemistry	3
FST 4534	Food Chemistry Lab	1
FST 4524	Food Safety and Quality Assurance	3
Subtotal		39
Option Required Courses		
HNFE 1004	Foods, Nutrition And Exercise	3
HNFE 2014	Nutrition Across the Life Span	3
PHYS 2205	General Physics	3
PHYS 2206	General Physics	3
CHEM 2535 & CHEM 2536	Organic Chemistry and Organic Chemistry	3-6
or CHEM 2514	Survey of Organic Chemistry	

Subtotal		15-18
Restricted Electives		
Select 10-13 credit hours of the following:		10-13
BMSP 2135	Human Anatomy & Physiology	
BMSP 2136	Human Anatomy and Physiology	
BMSP 2145	Human Anatomy and Physiology Laboratory	
BMSP 2146	Human Anatomy and Physiology Laboratory	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
FST 2014	Introduction to Food Science	
FST 2244	Topics in Food Science and Technology [1]	
FST/HNFE 2544	Functional Foods for Health	
FST 3024	Principles of Sensory Evaluation	
FST 4204	Advanced Topics in Food Science and Technology [1]	
FST 4634	Epidemiology Foodborne Disease	
FST 4974	Independent Study [1]	
FST 4994	Undergraduate Research [1]	
HNFE 4025	Metabolic Nutrition	
HNFE 4026	Metabolic Nutrition	
PHYS 2215	General Physics Laboratory	
PHYS 2216	General Physics Laboratory	
Study Abroad (As approved by FST department) [1]		
Free Electives		
Select remaining credits of free electives		9
Subtotal		19-22
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) and Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States [2]		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120-126**

[1] Credits vary depending on course, maximum of three credits allowed for each item.

[2] Pathways 7 may be completed with another Pathways requirement.

Eligibility for Continued Enrollment

1. After having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have passed at least 12 semester credits of Curriculum for Liberal Education requirements.
2. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must:
   a. have passed at least 24 semester credits of Curriculum for Liberal Education requirements.
   b. have passed 9 semester credits in the Food and Beverage Fermentation Option requirements.

Graduation Requirements

This check sheet contains no hidden prerequisites. Please refer to the Undergraduate Course Catalog or consult your advisor for information about prerequisites.

1. A minimum of 120 credit hours are required for graduation.
2. A minimum 2.0 overall GPA is required for graduation.
3. A minimum 2.0 in-major GPA is required for graduation (only FST courses will be used for in-major GPA calculation).

Foreign Language Requirement

A sequence of 2 foreign languages courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credits of foreign language have been earned. These credits do not count toward graduation.

1.

Food Science and Technology Major with Food Business Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
BCHM 2024	Concepts of Biochemistry	3
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	2

FST 2004	Exploring Food Science Careers	1
FST 3514	Food Analysis	4
FST/BIOL 3604	Food Microbiology	4
FST 3900	Bridge Experience	0
FST 4004	Food Science Experiential Learning Reflection	1
FST 4014	Concepts of Food Product Development	3
FST 4304	Food Processing	3
FST 4314	Food Processing Laboratory	1
FST 4504	Food Chemistry	3
FST 4534	Food Chemistry Lab	1
FST 4524	Food Safety and Quality Assurance	3
Subtotal		39
Option Required Courses		
ACIS 2115	Principles of Accounting	3
ACIS 2116	Principles of Accounting	3
BIT 3414	Operations and Supply Chain Management	3
CHEM 2514	Survey of Organic Chemistry	3
FIN 3104	Introduction to Finance	3
or AAEC 3424	Value-Based Management in Agribusiness	
MGT 3304	Management Theory and Leadership Practice	3
or AAEC 3454	Small Business Management and Entrepreneurship	
MKTG 3104	Marketing Management	3
or AAEC 3504	Marketing Agricultural Products	
Subtotal		21
Restricted Electives		
Select nine credit hours of the following:		9
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
APSC/FST 3214	Principles of Meat Science	
BIT 3464	Enterprise Planning and Control Systems	
FIN 3054	Legal and Ethical Environment of Business	
FST 2014	Introduction to Food Science	
FST/IS/PSCI 2044	Food, War and Conflict	
FST 2244	Topics in Food Science and Technology	
FST/HNFE 2544	Functional Foods for Health	
FST 3024	Principles of Sensory Evaluation	
FST/HORT 3114	Wines and Vines	
FST 3124	Brewing Science and Technology	
FST 4104	Applied Brewing Science and Engineering	
FST 4204	Advanced Topics in Food Science and Technology	
FST 4634	Epidemiology Foodborne Disease	
FST 4974	Independent Study [1]	
FST 4994	Undergraduate Research [1]	
HNFE 1004	Foods, Nutrition And Exercise	
HNFE 3024	Science of Food Prep Lab	
MGT 3324	Organization Behavior	
MGT/PHIL 4324	Business and Professional Ethics	
MKTG 4154	Marketing Research	
MKTG 4204	Consumer Behavior	
MKTG 4254	Product and Price Management	
Study Abroad (As approved by FST department) [1]		
Subtotal		9
Free Electives		
Select three credits of free electives		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5A)	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F)	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5F)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) and Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States [2]		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		48
Total Credits		**120**

[1] Credits vary depending on course, maximum of three credits allowed for each item.

[2] Pathways 7 may be completed with another Pathways requirement.

Eligibility for Continued Enrollment

1. After having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have passed at least 12 semester credits of Curriculum for Liberal Education requirements.

2. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must:
   a. have passed at least 24 semester credits of Curriculum for Liberal Education requirements.
   b. have passed 9 semester credits in the Food Science and Technology requirements.
   c. have passed 9 semester credits in the Food Business Option requirements.

Graduation Requirements

1. A minimum of 120 credit hours are required for graduation.
2. A minimum 2.0 overall GPA is required for graduation.
3. A minimum 2.0 in-major GPA is required for graduation (only FST courses will be used for in-major GPA calculation).
4. This check sheet contains no hidden prerequisites. Please refer to the Undergraduate Catalog or consult with your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign languages courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credits of foreign language have been earned. These credits do not count toward graduation.

Food Science and Technology Major with Science Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
BCHM 2024	Concepts of Biochemistry	3
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	2
FST 2004	Exploring Food Science Careers	1
FST 3514	Food Analysis	4
FST/BIOL 3604	Food Microbiology	4
FST 3900	Bridge Experience	0
FST 4004	Food Science Experiential Learning Reflection	1
FST 4014	Concepts of Food Product Development	3
FST 4304	Food Processing	3
FST 4314	Food Processing Laboratory	1
FST 4504	Food Chemistry	3
FST 4534	Food Chemistry Lab	1
FST 4524	Food Safety and Quality Assurance	3
Subtotal		39
Option Required Courses		
CHEM 2535	Organic Chemistry	3
CHEM 2536	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
FST 3024	Principles of Sensory Evaluation	3
HNFE 1004	Foods, Nutrition And Exercise	3
PHYS 2205	General Physics	3
Subtotal		16
Restricted Electives		
Select 12 credit hours of the following:		12
BIOL 4674	Pathogenic Bacteriology	
BIOL 4704	Immunology	
CHEM 4554	Drug Chemistry	
FST 2014	Introduction to Food Science	
FST/IS/PSCI 2044	Food, War and Conflict	
FST 2244	Topics in Food Science and Technology [1]	
FST/HNFE 2544	Functional Foods for Health	
FST 3024	Principles of Sensory Evaluation	
FST/HORT 3114	Wines and Vines	
FST 3124	Brewing Science and Technology	
FST/APSC 3214	Principles of Meat Science	
FST 4104	Applied Brewing Science and Engineering	
FST 4204	Advanced Topics in Food Science and Technology [1]	
FST 4634	Epidemiology Foodborne Disease	
FST 4974	Independent Study [1]	
FST 4994	Undergraduate Research [1]	
HNFE 3024	Science of Food Prep Lab	
Study Abroad (As approved by FST department) [1]		
Subtotal		12
Free Electives		
Select six credits of free electives		6
Subtotal		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3

STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) and Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States [2]		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

[1] Credits vary depending on course, maximum of three credits allowed for each item.

[2] Pathways 7 may be completed with another Pathways requirement.

Eligibility for Continued Enrollment

1. After having attempted 36 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must have passed at least 12 semester credits of Curriculum for Liberal Education requirements.
2. After having attempted 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and freshman rule hours), students must:
   a. have passed at least 24 semester credits of Curriculum for Liberal Education requirements.
   b. have passed 9 semester credits in the Science Option requirements.

Graduation Requirements

This check sheet contains no hidden prerequisites. Please refer to the Undergraduate Course Catalog or consult your advisor for information about prerequisites.

1. A minimum of 120 credit hours are required for graduation.
2. A minimum 2.0 overall GPA is required for graduation.
3. A minimum 2.0 in-major GPA is required for graduation (only FST courses will be used for in-major GPA calculation).

Foreign Language Requirement

A sequence of 2 foreign languages courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credits of foreign language have been earned. These credits do not count toward graduation.

1.

Human Nutrition, Foods, and Exercise

Our Website (http://www.hnfe.vt.edu)

Overview

Human Nutrition, Foods, and Exercise (HNFE) is a unique department that examines aspects of human health, including psychosocial aspects of health, behavioral intentions, human movement and performance, and weight management with a focus on chronic disease and prevention. The curriculum builds on the biological, physical, and social sciences. Many health issues including obesity, heart disease, and cancer have been associated with a person's food intake and level of exercise. This has led to increasing emphases on health promotion and disease prevention, and nutrition and exercise professionals are integral members of the health care team. Additionally, students prepared in these content areas are sought after by healthcare professional programs such as nutrition and dietetics, physical therapy, occupational therapy, physician assistant, medicine, athletic training, pharmacy, dentistry, nursing etc. Expanding research by private and government agencies focusing on the role of nutrition and physical activity in health, growth, and aging has created a demand for graduates at the Bachelor of Science (B.S.), Master of Science (M.S.), and Doctor of Philosophy (Ph.D.) levels who have a background and interest in laboratory and experimental methods in nutrition, foods and exercise science. Faculty and staff in HNFE include interdisciplinary teams that work towards molecular and clinical advances for the prevention and improved treatment of chronic diseases, behavioral discoveries that lead to effective intervention programs for youth and adults and speed the movement from research to practice.

Undergraduate students earn a Bachelor of Science degree in Human Nutrition, Foods, and Exercise with a major in Exercise and Health Sciences and/or Nutrition and Dietetics.

The department participates in the university's Honors Program.

HNFE offers master's and doctoral degrees in specialized areas as they relate to nutrition, physical activity, and health. Graduate students may earn a M.S. or a Ph.D. in HNFE with an emphasis in Molecular and Cellular Science, Clinical Physiology and Metabolism, or Behavioral and Community Science. HNFE also offers a M.S. in Nutrition and Dietetics. Completion of the M.S. in Nutrition and Dietetics leads to eligibility to become a Registered Dietitian Nutritionist (RDN).

Exercise and Health Sciences (EAHS)

Consult: Renee Eaton, Undergraduate Program Director

Students in the Exercise and Health Sciences (EAHS) major are well-prepared for graduate work in many areas of nutrition, exercise physiology, or related sciences. This major also meets admission requirements for medical, dental, physical therapy, pharmacy, physician assistant, athletic training, nursing, and other health professions programs. Flexibility to tailor the degree toward individual long-term goals, including continued education in a health profession or employment, is a key feature of the major. Students who enter the workforce have position titles such as patient care coordinator, clinical technician, fitness and health program coordinator, clinical research coordinator, medical scribe, surgical technician, rehabilitation aide, hospital recruiting specialist, exercise physiologist, health coach, strength and conditioning coach, hospital credentialing specialist, medical device sales associate, and health educator. Students in this major gain knowledge, skills, and abilities specified by the American College of Sports Medicine for certification as an Exercise Physiologist and Clinical Exercise Physiologist as well as the National Strength and Conditioning Association for certification as a Strength and Conditioning Specialist. With the growing attention to the role of nutrition and exercise in health promotion and disease prevention, the EAHS major is especially appropriate for the student preparing for a career in medicine, physical therapy, or a related health field. Most students in the EAHS plan to attend graduate or professional school. Students in the EAHS major must

maintain an overall GPA of 2.5 to remain in the major. Please see the Satisfactory Progress section for additional requirements.

Students in the EAHS major do not meet the ACEND® requirements for a degree in dietetics, and therefore do not earn a DPD Verification Statement. Students, however, may choose to major in both EAHS and Nutrition and Dietetics.

Nutrition and Dietetics (NAD)

Consult: Heather Cox, Director, Didactic Program in Dietetics

The Nutrition and Dietetics (NAD) major is a Didactic Program in Dietetics (DPD), fully accredited by the Accreditation Council for Education in Nutrition and Dietetics (ACEND®). ACEND® is the education program accrediting agency of the Academy of Nutrition and Dietetics and is recognized by the U.S. Department of Education as a Title IV gatekeeper. Following completion of the B.S. degree, a student will have earned an ACEND® DPD Verification Statement. A student must then complete a graduate degree and an ACEND®-accredited supervised practice program in nutrition and dietetics to be eligible for the Registration Examination for Dietitians. Examples of eligible pathways to the RDN credential include a graduate dietetics program or graduate program completed before, or along with, a dietetic internship. Graduates from the NAD major are competitive applicants for the varied ACEND®-accredited supervised practice programs.

Nutrition and Dietetics students are also eligible to apply to the accelerated track of the HNFE Master of Science in Nutrition and Dietetics in the spring semester before they begin their final academic year. Accepted students are dual enrolled in the B.S. and M.S. programs and complete eligibility to take the board exam to become a Registered Dietitian Nutritionist (RDN) in an accelerated route.

The NAD major prepares graduates to assume a professional role in health care, research, the business/industry environment, public health, and to pursue graduate studies. Most alumni pursue adietetics supervised practice program and become an RDN. Clinical RDNs in hospitals and outpatient clinics provide care to individuals with disease-related nutritional problems. Sports RDNs work with professional sports teams or university sports teams. Community RDNs work in cooperative extension, worksite wellness programs, and community programs serving mothers and children, families of low-income, or older individuals. Business focused RDNs work for food and grocery companies, companies manufacturing nutritional supplements, and may represent medical or health products. Administrative RDNs with management interests find positions in management in a variety of settings such as school nutrition, health care facilities, college or university dining, or hotels and resorts. Registered Dietitians Nutritionists counsel clients of all ages, cultural and ethnic backgrounds, and levels of education.

Students in the NAD major must maintain an overall GPA of 3.0 to remain in the major. Students who want to change their major into NAD must have an overall GPA of 3.0. Please see the Satisfactory Progress section for additional requirements.

Satisfactory Progress

A student in HNFE will be considered to have made satisfactory progress toward the degree when they have successfully completed:

- Overall GPA 3.0 or higher (NAD) or 2.5 or higher (EAHS)
- Grade of C or better in HNFE 1004 Foods, Nutrition And Exercise
- Grade of C- or better in CHEM 1036 General Chemistry, CHEM 1036 General Chemistry, and CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.
- These courses must be completed by the time the student has attempted 72 hours:
  - BIOL 1105 Principles of Biology-BIOL 1106 Principles of Biology or equivalent
  - CHEM 1035 General Chemistry-CHEM 1036 General Chemistry or equivalent
  - CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry
  - HNFE 1004 Foods, Nutrition And Exercise

Students not meeting Satisfactory Progress will have one probationary semester in which to resolve their standing.

Nutrition and Dietetics Restricted Major status: Current Virginia Tech students who wish to change majors to NAD (or add it as a second major) are required to have an overall GPA at or above 3.0 , a grade of C- or higher in CHEM 1035 General Chemistry, and a plan of study that shows appropriate course sequencing and Satisfactory Progress. The GPA threshold of 2.5 (EAHS) and 3.0 (NAD) is required for all students regardless of transfer status. Satisfactory progress towards the B.S. degree is enforced.

- Exercise and Health Sciences Major (p. 542)
- Nutrition and Dietetics Major (p. 544)

Head: Stella L. Volpe
Professors: G. Davis, B. Davy, K. Davy, R. Grange, E. Larson-Meyer, D. Liu, E. Serrano, E. Schmelz, S. Volpe, and J. Williams
Associate Professors: D. Good, S. Harden, Y. Ju, and V. Kraak
Assistant Professors: J. Basso, S. Craige, A. DiFeliceantonio, J. Drake, V. Hedrick, C. Rafie, S. Shin, and J. Stein
Collegiate Associate Professor: A. Anderson
Senior Instructors: H. Cox, N. Girmes-Grieco, and C. Papillon
Advanced Instructor: R. Eaton
Instructors: K. Chang and A. LaFalce
Adjunct Instructors: M. Rockwell, A. Steketee
Academic Advisors: E. Engel, S. Nelson, D. Pollio, and K. Wogenrich

Undergraduate Course Descriptions (HNFE)

HNFE 1004 - Foods, Nutrition And Exercise (3 credits)
Scientific information applied to current concerns in foods, nutrition and exercise as it affects the nutritional health well-being of humans. I,II
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 1114 - Orientation to HNFE (1 credit)
An introduction to the academic and career planning for students in the Human Nutrition, Foods & Exercise major.
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1214 - Topics in Lifetime Activities (1 credit)
Participation in physical activity, fitness assessment, motor skill development. Awareness and development of the physical, spiritual, emotional, social, and intellectual components of wellness. Application of healthy lifestyle choices for improved quality of life. May be repeated with varying content, for a maximum of 6 credits. Pass/Fail Only
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 6 credit hours

HNFE 1215 - Meraki Living Learning Community, Be Well, Be You (1 credit)
Introduces students in the Meraki Living Learning Community to six dimensions of well-being: purpose, social, financial, community, physical, and emotional. Classroom learning, guided practice, connection to well-being resources, and individual exploration to promote lifelong holistic health and well-being. Personal well-being focused on developing a concept of self, understanding purpose, and learning positive health behaviors to support physical activity, nutrition, mindfulness, and personal finance.
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1216 - Meraki Living Learning Community, Be Well, Be You (1 credit)
Introduces students in the Meraki Living Learning Community to six dimensions of well-being: purpose, social, financial, community, physical, and emotional. Classroom learning, guided practice, and individual exploration to promote lifelong holistic health and well-being. Community well-being focused on mental health initiatives, student leadership, developing and sustaining relationships, and service.
Prerequisite(s): HNFE 1215
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 1804 - Principles of Sport Science (3 credits)
Introduction to the principal concepts of improving human physical capacity through sport, exercise training and diet. Emphasis on critical thinking and evidence-based decision making in describing the limits to human performance, responses, adaptations, and health benefits of exercise.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2004 - Professional Dietetics (1 credit)
Introduction to the profession of dietetics with emphasis on competencies, preparation, and responsibilities associated with dietetic practice. Overview of the structure of The American Dietetic Association (ADA) and its relationship to the dietetic professional. Discussion of current professional concerns. II
Corequisite(s): HNFE 2014
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 2014 - Nutrition Across the Life Span (3 credits)
Nutritional requirements and related health concerns of pregnant and lactating women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036.
Prerequisite(s): HNFE 1004
Corequisite(s): CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2014H - Nutrition Across the Life Span (3 credits)
Nutritional requirements and related health concerns of pregnant and lactacting women, infants, children, adults and the elderly are studied in relation to the physiological and metabolic aspects of pregnancy, lactation, growth and development, maintenance of health, prevention of disease, and aging. 1 year of biology or chemistry required. CHEM 1056 may be substituted for co-requisite CHEM 1036.
Prerequisite(s): HNFE 1004
Corequisite(s): CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2104 - Moving Body, Moving Mind (3 credits)
Methods of working intentionally towards cultivating optimal brain states. Mind/body practices to develop connections between contemporary neuroscience, movement, and meditative practices. Studies in the intersection of consciousness, movement, and thought. Introduction to yoga, meditation, authentic movement, experiential anatomy, and somatic work. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to the practices of intentional embodiment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: DANC 2104

HNFE 2204 - Medical Terminology (3 credits)
Structure, pronunciation, and use of medical terms; anatomical structures and body systems; terms used in pathology, testing, diagnosis, surgery, pharmacology and treatment.
Prerequisite(s): (BIOL 1005 or BIOL 1105 or BIOL 1205H) and (BIOL 1006 or BIOL 1106 or BIOL 1206H) or ISC 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2254 - Exercise Leadership - Group Fitness Instructor (3 credits)
Development of theoretical and practical skills for leading exercise in a group setting. Topics include: general guidelines for instructing safe, effective, and purposeful exercise, essentials of the instructor-participant relationship, the principles of motivation to encourage adherance in the group fitness setting, effective instructor-to-participant communication techniques, methods for enhancing group leadership, and the group fitness instructors professional role. Obtain knowledge of programming for multiple populations. Will complete a CPR and AED certification as a part of in-class instruction. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2264 - Exercise Leadership- Personal Trainer (3 credits)
Development of practical skills for conducting one-on-one exercise sessions for general healthy adults and special populations. Exercise selection, testing, training principles, and behavioral change skills required to be an effective personal trainer. Preparation for a nationally accredited personal training certification. CPR and AED certification. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2274 - Wilderness First Responder (3 credits)
Assessment and treatment of emergencies in remote settings. Anatomy, physiology, and pathophysiology, personal and group safety and hygiene, patient assessment and documentation of treatment for trauma, medical emergencies, environmental emergencies, and long-term care. Team management of medical emergencies in wilderness context, organization and implementation of rescues, decision-making, leadership, judgment, and prevention. Prepares students to successfully complete a national certification exam. Pass/fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 2314 - Active Transportation for a Healthy, Sustainable Planet (3 credits)
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 2314

HNFE 2334 - Introduction to Integrative Health (3 credits)
Introduction to the principles of integrative health that promote health and well-being. Examination of the person- centered integrative health treatment methods including holistic stress management, the human spirit, communication, energy healing, elements of meditation, healing environments, Chinese medicine, Ayurvedic medicine, voice work, nutrition, therapeutic massage and bodywork, and healing effects of physical activity. Review of scientific evidence of integrative treatments.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2484 - Evidence-Based Practice in Health Science (1 credit)
Evidence-based practice in the field of health science. Utilization and evaluation of published research in literature. Answers to health and healthcare related questions. Identification of well-defined research questions using current frameworks. Best practices of healthcare policies.
Prerequisite(s): HNFE 1004
Corequisite(s): HNFE 2014
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 2544 - Functional Foods for Health (3 credits)
Introduction to functional foods (foods with additional value beyond basic nutrition) including development of functional foods, novel sources, and traditional foods with value-added health benefit; regulatory issues; and media messages.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2544

HNFE 2664 - Behavioral Theory in Health Promotion (3 credits)
Introduction to behavioral theories used to design, implement and evaluate health promotion programs, and theories underlying health behavior change. Interactions between individuals, physical and social environments, interpersonal, and intrapersonal determinants of health behavior. Epidemiological evidence of benefits of healthful eating and physical activity.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2774 - Topics in HNFE (1-3 credits)
A variable-content course. Explores significant contemporary topics in the areas of nutrition, foods, exercise and health. May be repeated for up to six credits.
Prerequisite(s): HNFE 1004
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

HNFE 2804 - Exercise and Health (3 credits)
Introduction to the foundations of exercise science as applied to healthy living, and the concept of exercise as medicine. Fundamentals of health appraisal, foundations of fitness training principles and prescription; nutrition and energy cost, and application of exercise prescription for disease prevention and treatment.
Prerequisite(s): HNFE 1004 and BMSP 2135
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 2824 - Prevention and Care of Athletic Injuries (2 credits)
An introduction to the techniques and principles of athletic training. I,II.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 2954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 2984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

HNFE 2984N - Special Study (1-19 credits)
Pathway Concept Area(s): 1F Discourse Foundational
Instructional Contact Hours: Variable credit course

HNFE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 3024 - Science of Food Prep Lab (2 credits)
Application of the principles of food science and food preparation techniques related to health promotion, disease prevention, and disease management. Selection, production, and evaluation of foods and beverages. Emphasis on experimentation illustrating chemical and physical reactions, sensory and physical properties, nutrient manipulation, cooking applications, and functions of foods.
Prerequisite(s): (HNFE 1004 and CHEM 1036) or CHEM 1056 or (ISC 2106 and FST 2014)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 3034 - Methods of Human Health Assessment (2 credits)
Evidence-based practice in areas of human health assessment including: anthropometric measurements, vital signs, body composition, aerobic capacity, muscular strength, energy requirements, and health behaviors. Comparison and analysis of assessment methods.
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and BMSP 2136
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 3114 - Foodservice and Meal Management (4 credits)
Foodservice and meal management for the dietetics professional. Emphasis is placed on understanding food procurement, production, distribution, and marketing in a safe and well managed operation. I
Prerequisite(s): HNFE 3024 or HNFE 2224
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

HNFE 3224 - Communicating with Food (3 credits)
Development of oral and written communication skills to communicate food and nutrition information to diverse populations. II
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and (HNFE 3024 or HNFE 2224)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 3634 - Epidemiologic Concepts of Health and Disease (3 credits)
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied. II.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 3634

HNFE 3804 - Exercise Physiology (3 credits)
Effects of exercise on physiology: neuromuscular, metabolic, cardiopulmonary. Scientific basis of physical training. I
Prerequisite(s): BMSP 2136 and HNFE 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 3824 - Kinesiology (3 credits)
The anatomical and biomechanical basis of human motion, with applications for motor skill acquisition, and development and rehabilitative exercises. I
Prerequisite(s): BMSP 2135 and BMSP 2136
Corequisite(s): PHYS 2205 or PHYS 2305.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4004 - Seminar in HNFE: Writing and Discourse in the Major (3 credits)
Focused review of relevant and current literature in selected areas of food, nutrition and exercise. Develop practical strategies for finding research articles on specific topics utilizing a variety of search tools (e.g., library, on-line search engines, etc.). Develop analytical skills to critically assess the significance of published research data. Develop competence in written and verbal presentation of current research in formats suitable for a scientific or a lay audience.
Prerequisite(s): COMM 2004 or ALCE 3634 and HNFE 2484
Corequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4024 - Emerging Issues in Dietetics (1 credit)
Investigation of emerging dietetics topics including professional development, new technologies, current legislative issues, and promising evidence-based practice strategies. Integration of knowledge from previous courses to support quality dietetics practice will be emphasized.
Prerequisite(s): HNFE 4026
Corequisite(s): HNFE 4125
Instructional Contact Hours: (1 Lec, 1 Crd)

HNFE 4025 - Metabolic Nutrition (3 credits)
4025: Study of bioenergetics and macronutrients, with emphasis on sources, interrelationships, and factors affecting utilization and metabolism. Emphasis on how carbohydrates, lipids, and proteins are metabolized following a meal, during fasting conditions, and when exercising. How metabolism of carbohydrates, lipids and proteins affects and is effected by metabolic disease such as obesity and diabetes will also be examined. 4026: Study of essential vitamins and minerals and their interaction with body systems, especially as these relate to food, exercise and health. Emphasis on how deficiency, toxicity and genetic conditions affect various organ systems, including bone, skin, digestive, and blood. Historical and regulatory policies, and scientific studies establishing recommended dietary allowances for micronutrients are considered.
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and (BCHM 2024 or BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4026 - Metabolic Nutrition (3 credits)
Prerequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4114 - Food and Nutritional Toxicology (3 credits)
Principles of food and nutritional toxicology with primary emphasis on food components and food toxins including absorption, metabolism and excretion. An overview of types of adverse food reactions including food allergy, food sensitivity, and food intolerance. An overview of U.S. and international lawas and regulation of safety assessment of foods including food additives, dietary supplements, and residues of contaminants, pesticides, and antibiotics. Analysis of food and nutritional toxicity cases in the context of the food system, regulatory policies, and public communication.
Prerequisite(s): BMSP 2136 and BCHM 2024 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4125 - Medical Nutrition Therapy (3 credits)
Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. 4125: Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. 4126: Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states.
Prerequisite(s): HNFE 2004 and HNFE 4026
Corequisite(s): HNFE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4126 - Medical Nutrition Therapy (3 credits)
Study of nutritional diagnostic, therapeutic and counseling services provided by a registered dietitian. 4125: Emphasis on the relationship between principles of nutritional care and the medical treatment of individuals with selected diseases or clinical problems. 4126: Integration of knowledge of pathophysiology, biochemical, and clinical parameters, medical treatment and nutrition therapy for patients with selected clinical problems/disease states. 4125: I. 4126: II.
Prerequisite(s): HNFE 4125
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4134 - Experiential Approach to Nutritional Therapy (2 credits)
Use of didactic and experiential methods to learn and apply theories of behavior change in diverse nutrition counseling situations. Pre: Instructor approval. I
Prerequisite(s): HNFE 4644
Corequisite(s): HNFE 4125
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4174 - Nutrition and Physical Performance (3 credits)
Nutritional requirements for the wellbeing and optimal performance of athletes. Methods of assessment and modification of diet, performance, and body composition in athletes. Evaluation of dietary ergogenic aids and supplements for performance and body composition.
Prerequisite(s): HNFE 2804
Corequisite(s): HNFE 4025
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4224 - Alternative and Complementary Nutrition Therapies (2 credits)
Critical evaluation of health claims, mechanisms of action, and research literature for a wide variety of alternative nutrition therapies used for disease prevention and treatment. Practical application of knowledge through completion of problem-based learning projects.
Prerequisite(s): (BIOL 1005 or BIOL 1105 or BIOL 1205H) and (BIOL 1006 or BIOL 1106 or BIOL 1206H) and (CHEM 1036 or CHEM 1056) or ISC 2106 and HNFE 2484
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4254 - Experimental Foods (2 credits)
Experimental study of the functions of ingredients and factors affecting food quality with emphasis on an independent project.
Prerequisite(s): HNFE 3234
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 4354 - Dietary Supplements and Health (3 credits)
Practical and fundamental aspects of widely used dietary supplements (micronutrients, macronutrients, prebiotics, probiotics, plant extracts, bioactive compounds,). Efficacy and mechanism of dietary and botanical supplements in weight management, health promotion, and disease prevention. Interaction of dietary supplements with gut microbiome. Safety and regulatory considerations of dietary supplements. Project-based learning practice with the integration of literature review, project development, writing, and oral presentation.
Prerequisite(s): (BCHM 2024 or BCHM 3114) and (BMSP 2136 and HNFE 2484)
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4514 - Nutritional Genomics (3 credits)
Interactions between foods and nutrients with genetics, genomic DNA, and gene expression in humans and animals. Genetic variants that affect optimal health, metabolism and nutrition in individuals, as well as inheritance of these variants in individuals, and allele frequencies in populations. Scientific, ethical, and legal considerations of genes and nutrition knowledge, personalized testing, and genetic engineering. Junior standing.
Prerequisite(s): HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4624 - Community Nutrition (3 credits)
The application of nutrition principles to an analysis of current applied nutrition programs and a study of the political and legislative processes affecting the practice of dietetics. I
Prerequisite(s): (HNFE 2014 or HNFE 2014H) and HNFE 4026
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4634 - Socio-Cultural Food Systems (3 credits)
Study of social, cultural, and economic aspects of food systems, using quantitative and qualitative methods to assess nutritional status.
Prerequisite(s): HNFE 1004 and SOC 3004
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

HNFE 4644 - Health Counseling (3 credits)
Roles, responsibilities, legal requirements and scope of the health professional. Interviewing, counseling, education, health promotion and behavior change strategies for diverse populations. Guidance and referral, health assessment, communication skills, and problem-solving. Application of counseling techniques such as goal-setting, ethical practice, cultural competence, evidence-based practice. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4645 - Applications in Nutrition Counseling (2 credits)
4645: Experiential methods to apply theories of behavior change to promote nutrition and health changes. Learn and apply nutrition care process using evidence-based knowledge through providing client-centered counseling to individuals. Understanding of contemporary issues related to behavior change and emerging issues through review of lay and professional literature. 4646: Advance nutrition counseling skills through work with more diverse clients. Learn and apply quality improvement skills to enhance nutrition counseling service. Identify information on emerging issues and apply appropriately in counseling setting.
Prerequisite(s): HNFE 4644
Corequisite(s): HNFE 4125
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4646 - Applications in Nutrition Counseling (2 credits)
Prerequisite(s): HNFE 4645
Instructional Contact Hours: (2 Lec, 2 Crd)

HNFE 4754 - Advanced Human Anatomy and Pathophysiology (3 credits)
Advanced laboratory course in human anatomy and physiology with an emphasis on how pathologic disease states affect human homeostasis. Congenital, genetic, chronic, and common global diseases with recognition and evaluation of causes, risk factors, and impact on body systems. Cadaver prosections will supplement models, specimens, and an advanced anatomy visualization system. Intended for students pursuing graduate education in health sciences.
Prerequisite(s): BMSP 2136 and BMSP 2146
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HNFE 4774 - Advanced Contemporary Topics in HNFE (1-3 credits)
A variable-content course. Explores advanced topics in the areas of nutrition, foods, exercise or health using higher- order thinking and problem-solving skills. Qualitatively and quantitatively assess current facts supported by scientific literature, as well as controversial issues with conflicting data. May be repeated for a maximum of six credits. Junior Standing.
Prerequisite(s): HNFE 2014 or HNFE 2014H and HNFE 2484
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

HNFE 4804 - Exercise Metabolism and Disease (3 credits)
Explores the role of exercise in the pathophysiology of human metabolic disease with an emphasis on obesity, diabetes, insulin resistance, and exercise tolerance at whole body, cellular and molecular level dysfunction. In-depth assessment of the prospect of exercise as preventive and therapeutic for treatment of metabolic diseases.
Prerequisite(s): HNFE 4025 and HNFE 2804
Corequisite(s): HNFE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4814 - Advanced Athletic Injuries (2 credits)
Medical documentation and administration. Practical experience in locating, identifying, and evaluating anatomic structures Mechanisms of injury and healing process, testing and evaluation of athletic injuries, treatment and rehabilitation of injury to return to play. Not part of an accredited athletic training program.
Prerequisite(s): HNFE 2824 and HNFE 3804
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HNFE 4824 - Advanced Kinesiology (3 credits)
Advanced study of human movement during exercise. Integration of biomechanical, anatomical and neuromuscular concepts in the regulation of joint movement associated with exercise, injury and disease.
Prerequisite(s): HNFE 3824 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4834 - Applications in Clinical Exercise (3 credits)
Supervised experience with the Therapeutic Exercise and Community Health Center. Direct Involvement with rehabilitative and preventive exercise and lifestyle programming for cardio-vascular, musculo-skeletal, and other conditions. Exercise leadership, case management, and daily operations. Included seminars, lab experience, and individual meetings with participants and supervisors, related projects.
Prerequisite(s): HNFE 3874
Instructional Contact Hours: (9 Lab, 3 Crd)

HNFE 4844 - Exercise and Neuromuscular Performance (3 credits)
Functional properties of the neuromuscular system. Emphasis placed on the acute and chronic responses of muscle in exercise, rehabilitation and the factors which determine human performance. Special emphasis on the molecular biological factors responsible for skeletal muscle development and differentiation, as well as adaptation to training and disease states, including activation of signal cascades responsible for the changes in muscle performance.
Prerequisite(s): HNFE 3804 and HNFE 2484
Instructional Contact Hours: (3 Lec, 3 Crd)

HNFE 4854 - Internship in Exercise Science and Health Promotion (1-3 credits)
Capstone internship experience in the fields of exercise science and/or health promotion. The student will be immersed in the day-to-day challenges and responsibilities of a practicing health-fitness professional. The 45 contact hours per credit will involve work experience in some aspect of exercise science and/or health promotion. Senior standing and Exercise and Health Promotion majors only. May be repeated for maximum 3 credits.
Prerequisite(s): HNFE 4834
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

HNFE 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HNFE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Exercise and Health Sciences Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
HNFE 1114	Orientation to HNFE	1
HNFE 1004	Foods, Nutrition And Exercise (C) [1]	3
BIOL 1105	Principles of Biology [1]	3
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1106	Principles of Biology [1]	3
BIOL 1116	Principles of Biology Laboratory [1]	1
HNFE 2014	Nutrition Across the Life Span [1]	3
or HNFE 2014H	Nutrition Across the Life Span	
HNFE 2484	Evidence-Based Practice in Health Science [1]	1
BMSP 2135	Human Anatomy & Physiology [1]	3
BMSP 2136	Human Anatomy and Physiology [1]	3
HNFE 2804	Exercise and Health [1]	3
CHEM 2514	Survey of Organic Chemistry (C-) [1]	3
or CHEM 2535	Organic Chemistry	
BCHM 2024	Concepts of Biochemistry [1]	3
or BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	
or BCHM 4115	General Biochemistry	
HNFE 3034	Methods of Human Health Assessment [1]	2
HNFE 4025	Metabolic Nutrition [1]	3
HNFE 4026	Metabolic Nutrition [1]	3
Subtotal		39
Major Requirements [1]		
BMSP 2145	Human Anatomy and Physiology Laboratory	1
BMSP 2146	Human Anatomy and Physiology Laboratory	1
HNFE 3804	Exercise Physiology	3
Select one of the following:		2
HNFE 4964	Field Study (Pass/Fail only)	
HNFE 4974	Independent Study	
HNFE 4994	Undergraduate Research	
or HNFE 499	Undergraduate Research	
HNFE 3954	Study Abroad	
Subtotal		7
Science Foundations [1]		
Complete a minimum of 4 credit hours from the following:		4
BIOL 2604	General Microbiology	
BIOL 2614	General Microbiology Laboratory	
CHEM 2536	Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
PHYS 2205	General Physics	
or PHYS 230	Foundations of Physics	
PHYS 2206	General Physics	
or PHYS 2306	Foundations of Physics	
PHYS 2215	General Physics Laboratory	

PHYS 2216	General Physics Laboratory	
Restricted Electives [1]		
Complete a minimum of 15 credit hours. 9 credits must be at the 3000-4000 level and at least 2 credits of HNFE Capstone.		13
HNFE 1804	Principles of Sport Science	
HNFE 2104	Moving Body, Moving Mind [3]	
HNFE 2204	Medical Terminology	
FST 2014	Introduction to Food Science	
HNFE 3024	Science of Food Prep Lab	
HNFE 2314	Active Transportation for a Healthy, Sustainable Planet [3]	
HNFE 2334	Introduction to Integrative Health	
HNFE 2544	Functional Foods for Health	
HNFE 2664	Behavioral Theory in Health Promotion [3]	
HNFE 2774	Topics in HNFE [4]	
HNFE 2824	Prevention and Care of Athletic Injuries	
HNFE 3634	Epidemiologic Concepts of Health and Disease	
HNFE 3824	Kinesiology	
HNFE 4174	Nutrition and Physical Performance	
HNFE 4644	Health Counseling	
HNFE 4754	Advanced Human Anatomy and Pathophysiology	
HNFE 4814	Advanced Athletic Injuries	
Capstone. Minimum of 2 credits		*2*
HNFE 4004	Seminar in HNFE: Writing and Discourse in the Major	
HNFE 4114	Food and Nutritional Toxicology	
HNFE 4224	Alternative and Complementary Nutrition Therapies	
HNFE 4354	Dietary Supplements and Health	
HNFE 4514	Nutritional Genomics	
HNFE 4774	Advanced Contemporary Topics in HNFE [4]	
HNFE 4824	Advanced Kinesiology	
HNFE 4844	Exercise and Neuromuscular Performance	
Subtotal		19
Free Electives		
Select remaining credit hours required to fulfill degree requirements.		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F) [2]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F) [2]	3
or COMM 1016	Communication Skills	
COMM 2004	Public Speaking (1A) [2]	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSYC 1004	Introductory Psychology	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry (C-) [1]	3
or CHEM 1055	General Chemistry for Chemistry Majors	
CHEM 1045	General Chemistry Laboratory [1]	1
or CHEM 1065	General Chemistry for Chemistry Majors Lab	
CHEM 1036	General Chemistry (C-) [1]	3
or CHEM 1056	General Chemistry for Chemistry Majors	
CHEM 1046	General Chemistry Laboratory [1]	1
or CHEM 1066	General Chemistry for Chemistry Majors Lab	
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
or MATH 1225	Calculus of a Single Variable	
or ISC 1105	Integrated Science I	
STAT 3615	Biological Statistics (5A)	3
Select 3 credits of Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) or Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select course that meets Concept 7 and another Concept. If course meets only Concept 7, Pathways credit reaches 47		
Subtotal		44
Total Credits		**120**

1. Included in in-major GPA.
2. Credit cannot be received for both COMM 1016 and COMM 2004 if COMM 1015-COMM 1016 was taken for Concept 1f.
3. Course is part of Pathways General Education and can be counted in both locations.
4. Topics in HNFE (2774 and 4774) are not taught on a regular basis.

Satisfactory Progress Towards the Degree: An HNFE (**Exercise and Health Sciences**) student will be considered to have made satisfactory progress toward the degree when:

1. Overall GPA ≥ 2.50.
2. A minimum grade of "C" is required in HNFE 1004 Foods, Nutrition And Exercise and a "C-" or better is required in CHEM 1035 General Chemistry and CHEM 1036 General Chemistry and CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.
3. These courses must be completed by the time the student has attempted 72 hours:

   BIOL 1105 Principles of Biology-BIOL 1106 Principles of Biology or equivalent.

   CHEM 1035 General Chemistry-CHEM 1036 General Chemistry or equivalent.

   CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.

   HNFE 1004 Foods, Nutrition And Exercise.

Graduation Requirements

Note: Completion of this major does NOT qualify a student to apply to an Accreditation Council for Education in Nutrition and Dietetics (ACEND) accredited Dietetic Internship.

Graduation Requirement: Overall GPA ≥ 2.50.

A minimum grade of "C" is required in HNFE 1004 Foods, Nutrition And Exercise and a "C-" or better is required in CHEM 1035 General Chemistry and CHEM 1036 General Chemistry and CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.

Foreign Language Requirement

A sequence of two foreign language courses is required for graduation unless two years of high school credits of the same foreign language or six transfer credits of one foreign language have been earned. These credits do not count towards graduation.

Nutrition and Dietetics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
HNFE 1114	Orientation to HNFE (not included in in-major GPA)	1
HNFE 1004	Foods, Nutrition And Exercise (C) [1]	3
BIOL 1105	Principles of Biology [1]	3
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1106	Principles of Biology [1]	3
BIOL 1116	Principles of Biology Laboratory [1]	1
HNFE 2014	Nutrition Across the Life Span [1]	3
or HNFE 2014H	Nutrition Across the Life Span	
HNFE 2484	Evidence-Based Practice in Health Science [1]	1
BMSP 2135	Human Anatomy & Physiology [1]	3
BMSP 2136	Human Anatomy and Physiology [1]	3
HNFE 2804	Exercise and Health [1]	3
CHEM 2514	Survey of Organic Chemistry (C-) [1]	3
or CHEM 2535	Organic Chemistry	
BCHM 2024	Concepts of Biochemistry [1]	3
or BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	
or BCHM 4115	General Biochemistry	
HNFE 3034	Methods of Human Health Assessment [1]	2
HNFE 4025	Metabolic Nutrition [1]	3
HNFE 4026	Metabolic Nutrition [1]	3
Major Requirements [1]		
HNFE 2004	Professional Dietetics	1
FST 2014	Introduction to Food Science	2
HNFE 3024	Science of Food Prep Lab	2
BIOL 2604	General Microbiology	3
BIOL 2614	General Microbiology Laboratory	1-2
HNFE 3114	Foodservice and Meal Management	4
HNFE 3224	Communicating with Food	3
HNFE 4644	Health Counseling	3
MGT 3304	Management Theory and Leadership Practice	3
AAEC 4814	Food and Health Economics	3
HNFE 4624	Community Nutrition (HNFE Capstone)	3
HNFE 4125	Medical Nutrition Therapy	3
HNFE 4126	Medical Nutrition Therapy	3
Subtotal		73-74
Free Electives		
Select three credits of free elective		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F) [2]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F) [2]	3
or COMM 1016	Communication Skills	
COMM 2004	Public Speaking (1A) [2]	3
or ALCE 3634	Communicating Ag and Life Sciences in Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSYC 1004	Introductory Psychology	3
Select one of the following:		3
PSYC 2084	Social Psychology	
HNFE 2664	Behavioral Theory in Health Promotion	
PSYC 2034	Developmental Psychology	
SOC 1004	Introductory Sociology	
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry (C-) [1]	3
or CHEM 1055	General Chemistry for Chemistry Majors	
CHEM 1045	General Chemistry Laboratory [1]	1
or CHEM 1065	General Chemistry for Chemistry Majors Lab	
CHEM 1036	General Chemistry (C-) [1]	3
or CHEM 1056	General Chemistry for Chemistry Majors	
CHEM 1046	General Chemistry Laboratory [1]	1
or CHEM 1066	General Chemistry for Chemistry Majors Lab	
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
or MATH 1225	Calculus of a Single Variable	
or ISC 1105	Integrated Science I	
STAT 3615	Biological Statistics (5A)	3
Select 3 credits of Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) or Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select course that meets Concept 7 and another Concept. If course meets only Concept 7, Pathways credit reaches 47		

Subtotal	44
Total Credits	**120-121**

[1] Included in in-major GPA.
[2] Credit cannot be received for both COMM 1016 and COMM 2004 if COMM 1015-COMM 1016 were taken for Concept 1f.

Satisfactory Progress Towards Degree: An HNFE (**Nutrition and Dietetics major**) student will be considered to have made satisfactory progress toward the degree when he/she has successfully completed:

1. Overall GPA ≥ 3.00.
2. A minimum grade of "C" is required in HNFE 1004 Foods, Nutrition And Exercise and a "C-" or better is required in CHEM 1035 General Chemistry and CHEM 1036 General Chemistry and CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.
3. These courses must be completed by the time the student has attempted 72 hours:

   BIOL 1105 Principles of Biology-BIOL 1106 Principles of Biology or equivalent.

   CHEM 1035 General Chemistry-CHEM 1036 General Chemistry or equivalent.

   CHEM 2535 Organic Chemistry or CHEM 2514 Survey of Organic Chemistry.

   HNFE 1004 Foods, Nutrition And Exercise.

Students not meeting Satisfactory Progress will have one probationary semester in which to resolve their standing. Students who do not return to good standing at the end of the probationary semester must leave the major. Internal or external transfers will be required to create a plan of study that demonstrates how the student will attain Satisfactory Progress in regards to coursework. The GPA threshold will stand for all students regardless of transfer status.

Graduation Requirements

Nutrition and Dietetics Graduation Requirements: Overall GPA 3.0

Nutrition and Dietetics is a restricted major. Students who wish to change into, transfer into, and/or continue to study within HNFE must have and maintain the following:

1. Overall GPA ≥ 3.0.

2. A minimum grade of “C” is required in HNFE 1004, and a “C-“or better is required in CHEM 1035, CHEM 1036 and CHEM 2514 or CHEM 2535.

Prerequisites for courses are listed in the Undergraduate Course Catalog and associated with the CRN hyperlink on the on-line Timetable. It is the responsibility of the student to make sure the prerequisites for each course have been met. HNFE checks for prerequisites both during course request and at the beginning of the semester. Students who enroll in a course for which they clearly have not satisfied the prerequisites or equivalent may be dropped from the course. Deliberate false statements testifying to the satisfaction of prerequisites constitute a violation of the honor code.

Foreign Language Requirement

A sequence of two foreign language courses is required for graduation unless two years of high school credits of the same foreign language or six transfer credits of one foreign language have been earned. These credits do not count towards graduation.

Code	Title	Credits
HNFE 2204	Medical Terminology	3
HNFE 2544	Functional Foods for Health	3
HNFE 2664	Behavioral Theory in Health Promotion	3
HNFE 4004	Seminar in HNFE: Writing and Discourse in the Major	3
HNFE 4174	Nutrition and Physical Performance	3
HNFE 4224	Alternative and Complementary Nutrition Therapies	2
HNFE 4514	Nutritional Genomics	3
HNFE 4645	Applications in Nutrition Counseling	2
HNFE 4754	Advanced Human Anatomy and Pathophysiology	3
HNFE 4774	Advanced Contemporary Topics in HNFE	1-3
BMSP 2145 & BMSP 2146	Human Anatomy and Physiology Laboratory and Human Anatomy and Physiology Laboratory	2
CHEM 2536	Organic Chemistry	3
STS 3314	Medical Dilemmas and Human Experience	3

School of Animal Sciences

Our Website (http://www.apsc.vt.edu)

Overview

The School of Animal Sciences offers two degree programs (Animal and Poultry Sciences and Dairy Science) as well as several options within each degree. With expert faculty in fields and species across the animal sciences, our students are well-trained in science-based education and hands-on learning for careers in the animal sciences as well as graduate and professional schools, such as veterinary school.

Degree Programs

Animal and Poultry Sciences

The Animal and Poultry Sciences degree provides students with a broad science-based education tailored to meet their needs and career goals. The program prepares students for careers in livestock, poultry, and equine industries, and with companion animals, laboratory animals, agribusiness, research, and teaching. The curriculum also provides preparation for professional schools including veterinary medicine, medical school and other health professions, as well as graduate school. This major combines education in the basic sciences of animal nutrition, genetics, and physiology with management principles as applied to the raising and merchandising of beef cattle, horses, poultry, sheep, swine, and their products, as well as pets and other companion animals. Students are encouraged to participate in independent studies, undergraduate research, and internship programs. Study abroad opportunities are also available.

Animal and Poultry Sciences Options

The Animal and Poultry Sciences curriculum allows students to tailor their education to their academic and career goals. Students combine an option and an emphasis based on their specific interests.

- Pre-vet option: Prepares students for post-graduate education such as veterinary, medical, pharmacy, and other professional schools.
- Science option: Designed for students whose interests include nutrition, physiology, genetics, behavior, biotechnology, food safety.
- Production-Business option: For students interested in careers in production management, extension, agricultural education, agribusiness, feed and pharmaceutical sales.
- Within each option, students select an emphasis in Companion/Lab Animal, Equine, Livestock, or Poultry.

Animal and Poultry Sciences Minors

Two minors are offered in the Animal and Poultry Sciences program: Animal and Poultry Sciences and Equine Science. Both minors require a minimum of 18 credits. Minor checksheets can be found at the following website - https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Dairy Science

The purpose of the Dairy Science degree is to offer students the opportunity to prepare themselves for a wide variety of careers by developing their technical and interpersonal skills. We offer a challenging yet flexible curriculum that can be individualized to meet the educational needs and interests of each student, counseling to assist each student in designing individual programs, and extracurricular activities to enhance development of interpersonal skills.

Dairy Science Options

Students may select from three curricula: Dairy Business Management, Science/Pre-Veterinary, and Dual Emphasis. All options provide students with the opportunity to acquire a broad education in the sciences, social sciences, economics, mathematics, and communications while learning the basic principles of dairy enterprise management.

- Dairy Business Management option: This is the most flexible curriculum, with at least 30 credits of electives. Suited to students with an interest in various fields of dairy production (herd manager, farm manager), allied agri-business industries (feed, genetics, equipment), agricultural communications, public relations, extension, breed field person, and a variety of other positions. Graduates in this option have also gone on to careers in college instruction, elementary school instruction, bank investment management, feed sales, and milk marketing, to name a few.
- Dual option: This is recommended for students who plan to concentrate in more than one academic area as they prepare for future careers. Common minors and double majors that students may earn while completing their Dairy Science degree requirements include Agricultural Economics, Animal and Poultry Sciences, Biology, Crop and Soil Environmental Sciences, Spanish, Communications, Professional and Technical Writing, etc.
- Science Pre-Vet option: This option is recommended for students who plan to continue into veterinary college or other graduate or professional schools, or who plan a career in quality control, laboratory work, or research and product development. It provides an excellent base in chemistry, mathematics, physics, biology and biochemistry for advanced study in many areas. Students are encouraged and mentored to apply for early admission to veterinary school.

Opportunities to Excel in Dairy Science

Nearly all Dairy Science students complete a second major or minor and they are encouraged to actively participate in extracurricular clubs, judging teams and the dairy management team. Ninety five percent of students complete at least one internship prior to graduation and nearly half complete undergraduate research, an independent study, or serve as a teaching assistant.

Active participation in research projects in lactation, genetics, nutrition, nutrient management, and management provide qualified students valuable research experience with departmental scientists as well as part-time employment opportunities. These opportunities are available to students in all options and enhance their preparation for advanced study and provide a better understanding of the research process.

Requirements for a Dairy Science Minor

Students may minor in Dairy Science. The minor requires the completion of a total of 19 credit hours. Courses that may be taken for the minor are listed on the minor checksheet found on the following website - https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Note: Advisors work with students to individualize the course of study.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Pathways) (see "Academics (https://www.undergradcatalog.registrar.vt.edu/1617/academic-policies.html)") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Animal and Poultry Sciences Major (p. 552)
- Dairy Science Major with Dairy Business Management Option (p. 554)
- Dairy Science Major with Dual Emphasis Option (https://catalog.vt.edu/undergraduate/agriculture-life-sciences/animal-sciences/dairy-science-dual-emphasis/)
- Dairy Science Major with Science/Prevet Option (p. 556)

Director: D. E. Gerrard
Horace E. and Elizabeth F. Alphin Professor of Dairy Science: A. D. Ealy
Colonel Horace E. Alphin Professor of Dairy Science: K. F. Knowlton
David R. and Margaret Lincicome Professor of Agriculture: M. D. Hanigan[6]
Paul Mellon Distinguished Professor of Agriculture: S. E. Johnson
John W. Hancock Professor: M. E. Persia
Professors: A. D. Ealy, M. J. Estienne, D. E. Gerrard, S. P. Greiner, M.D. Hanigan, H. Jiang, S. E. Johnson, J. W. Knight, K.F. Knowlton, J. J. Maurer, K. Medler, M. E. Persia, R. P. Rhoads Jr., and E. J. Smith
Associate Professors: F. Biase, B. A. Corl, R. Cockrum, K. M. Daniels, S. W. El-Kadi, D. E. Eversole, G. Ferreira, E. Feuerbacher, L. Jacobs, T. J. Jarome, C. S. Petersson-Wolfe, V. Mercadante, M. L. Rhoads, R. White, and C. M. Wood
Assistant Professors: A. Azahar, J. Chen, L. Gunter, R. Marques, and J. Osorio
Associate Professor of Practice: J. S. Bedore and M. Miller
Assistant Professor of Practice: K. J. Heiderscheit
A/P Faculty: M. Arant, K. Carter, T. Golightly, H. Liles, and B. Sheely
Advanced Instructor: L. Bergamasco and W. A. White
Lecturer: D. R. Winston
Research Associate Professor: T. Fernandes, and T.H. Shi
Research Assistant Professor: E.T. Helm and M. Lima

Career Advisors: J. S. Bedore, R. Cockrum, B. A. Corl, D. E. Eversole, K. J. Heiderscheit, and C. M. Wood

E-mail: ansci@vt.edu

Footnotes:

[1] Award for Excellence in Undergraduate Advising
[2] Academy of Teaching Excellence inductee
[3] Wine Award recipient
[4] Sporn Award recipient
[5] Alumni Award for Extension Excellence
[6] Alumni Award for Research Excellence
[7] Alumni Award for Teaching Excellence
[8] Academy of Faculty Service
[9] Commonwealth of Virginia Outstanding Faculty Award
[10] Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (APSC)

APSC 1454 - Introduction to Animal and Poultry Science (3 credits)
Survey of systems of livestock and poultry production including: concepts and terminology pertaining to management and marketing; types and breeds of livestock and poultry; and an introduction to nutrition, genetics, physiology, and management of beef cattle, horses, sheep, swine and poultry.
Corequisite(s): APSC 1464
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 1464 - Animal and Poultry Science Laboratory (1 credit)
Management practices and concepts related to efficient livestock and poultry production and marketing are taught through demonstrations and hands-on experience.
Corequisite(s): APSC 1454
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 1504 - Animal and Poultry Sciences First Year Experience (1 credit)
Orientation course for freshman and transfer APSC students providing skills, resources and fundamental knowledge to enhance learning experiences and support success. Skills, resources, opportunities, curriculum, and career planning. Emphasis on inquiry, problem-solving skills, critical thinking and integration of ideas and experiences to encourage life-long learning.
Instructional Contact Hours: (1 Lec, 1 Crd)

APSC 1524 - Beginning Equitation (1 credit)
Beginning work in equitation, the science of horseback riding. The five natural aids of the rider and rein aides. Secure positions of the rider's leg and seat at the walk, trot, and canter. Basic leg and seat position for jumping. Concepts of horse welfare, health, behavior, and communication pertaining to horseback riding. The German training scale, including rhythm, relaxation, connection, impulsion, straightness, and collection of the horse. Use of small cavaletti obstacle courses to improve horse strength and straightness. Grooming techniques, hoof care, and tack conditioning for equitation horses. Position emphasis will be on the forward riding seat and elementary dressage movements. COURSE FEE $1,500
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2004 - Animal and Poultry Sciences Seminar (1 credit)
Identification of primary and secondary career objectives for Animal and Poultry Science majors; planning for completion of a capstone learning experience in the major. Identification of curricular and extracurricular activities to increase career opportunities. Improvement of professional and technical writing skills applicable to the animal sciences field.
Prerequisite(s): APSC 1504
Instructional Contact Hours: (1 Lec, 1 Crd)

APSC 2104 - Poultry Laboratory (1 credit)
Anatomy and physiology of birds including species-specific specializations in anatomical structure and body composition, musculoskeletal, respiratory, reproductive, endocrine, digestive and urinary systems. Relationship of these concepts to growth and egg production. Includes handling live birds.
Prerequisite(s): APSC 1454 and APSC 1464
Corequisite(s): ALS 2304
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 2114 - Livestock Management and Handling (1 credit)
Safety in livestock handling; animal behavior; care, housing, and managerial practices related to beef cattle, sheep, and swine taught through experiential activities.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 2124 - Horse Handling Practicum (2 credits)
Stable management, haltering and leading horses, equine vital signs, and hoof care. Identification of horses by coat colors and markings. Breed characteristics of horses. Equine behaviors. Types and amounts of feed and forages commonly fed to horses. Anatomical parts of the horse. Careers in the horse industry and sports in which horses participate. Involvement with daily management and handling of the campus equitation and breeding horses.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

APSC 2164 - Companion and Laboratory Animal Care and Handling (1 credit)
Brief history of companion and laboratory animals. Outline of the major anatomical and physiological characteristics, first aid and basic care. Principles of husbandry and handling techniques. Institutional Animal Care and Use Committee training.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (2 Lab, 1 Crd)

APSC 2424 - Introduction to the Equine Industry (3 credits)
Introduction to the horse and equine industry. Survey of breeds and conformation; breeding, management, equipment, facilities, and marketing of the successful horse operation.
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2524 - Intermediate Equitation (1 credit)
Intermediate work in horseback riding with special emphasis on development of the forward seat and skills required for jumping. Elementary dressage movements. COURSE FEE: $1,500.
Prerequisite(s): APSC 1624
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 2574 - Domesticated Animal Behavior (3 credits)
Behavioral systems, social behavior, learning, and cognition of domesticated animals. Ethological and psychological approaches to, and ultimate and proximate methods of, studying behavior. Evolutionary processes and natural selection, genetics and epigenetics, and neural and physiological mechanisms of behavior.
Prerequisite(s): APSC 1454 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2624 - Beginning Equitation Over Fences (1 credit)
Introduction of jumping skills for the unskilled as well as review of jumping skills for experienced riders. Rider should have skills at trot and canter. COURSE FEE: $1,500.
Prerequisite(s): APSC 2524
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 2714 - Design of Precision Animal Agricultural Systems (3 credits)
Design methods, interpretation, and historical context of precision animal agriculture systems, including technologies, networking, sensors, and data analytics. Elements of animal production systems designed with precision animal agriculture technologies. Advantages and disadvantages of traditional and technology-enhanced production systems. Impacts of precision system design on economics and environmental impacts of animal agriculture and wellbeing. Data acquisition, pipelines, and analytics that link data with decision making. Design of connected systems.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 2824 - Equine Conformation and Biomechanics (2 credits)
Evaluation of equine conformation as related to locomotion, athletic performance and soundness. Basic understanding of breed standards, gaits, and rules and regulations pertaining to various equine sports disciplines, from both domestic and global perspectives. Investigation of current scientific literature regarding equine conformation and biomechanics.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

APSC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3024 - Equine Science and Management (3 credits)
Management of horses at maintenance, in light work, and breeding stock. Conformation, forages and concentrate requirements, common diseases and health conditions, health maintenance, vaccination and deworming protocols, behavioral modification and training practices, facility management, breeding practices, and welfare. Career paths in the horse industry. Emphasis on application and analysis of case studies.
Prerequisite(s): APSC 2124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

APSC 3064 - Companion and Laboratory Animal Science (3 credits)
Comparative aspects of companion and laboratory animals including physiology, anatomy, nutrition, genetics and reproduction. Normal behaviors along with techniques of behavior modifications.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3134 - Animal Agriculture and the Environment (3 credits)
Environmental issues associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: DASC 3134

APSC 3214 - Principles of Meat Science (3 credits)
Muscle biology and biochemistry, fresh meat processing, meat merchandising, processed meats, food safety, meat cookery, and regulations.
Prerequisite(s): ALS 2304 and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 3214

APSC 3224 - Meat Science Laboratory (1 credit)
Harvesting of livestock, carcass fabrication into wholesale and retail cuts, fresh meat processing and cookery. Handling, processing and displaying fresh and processed beef, pork, and lamb. Applications of Hazard Analysis Critical Control Point (HACCP) and food safety concepts to meat processing environments.
Corequisite(s): APSC 3214
Instructional Contact Hours: (3 Lab, 1 Crd)

APSC 3254 - Animal Products (3 credits)
Products obtained from animals (meat, eggs, dairy, by-products). Effect of production and processing of food animals upon product safety and quality.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

APSC 3334 - Animal Welfare and Bioethics (3 credits)
Historical overview of animal welfare and bioethics. Animal welfare issues in farm and companion animals with respect to their use and treatment in the United States and in the global community. The influences of animal protection organizations, consumer groups, politicians, the scientific community, and other stakeholders on the development and enforcement of policies. Pre: Junior Standing.
Prerequisite(s): APSC 1454 and ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3434 - Host Microbe Interactions (3 credits)
Microbes and their physiology in animal production. Host-microbe interactions at a cellular/system level. Microbial pathogenesis, microbiome, and metabolism in animal health. Cellular responses to microbe colonization of its animal host. Relate microbial metabolism with diet and animal growth and development. Examine the underlying mechanism behind disease or health resulting from microbe interactions.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3504 - Poultry Science and Health (3 credits)
Avian embryology and physiological systems, poultry genetics, microbiome, diseases, biotechnology, health and welfare. Social and economic issues facing the poultry industry.
Prerequisite(s): APSC 1454 and APSC 1464
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 3524 - Intermediate Equitation Over Fences (1 credit)
Establishment of sound jumping skills. Continuation of more advanced flat work. Study of hunter courses and cross country jumping. COURSE FEE: $1,500.
Prerequisite(s): APSC 2624
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 3624 - Advanced Equitation Over Fences (1 credit)
Advanced methods and techniques for jumping and precision riding. COURSE FEE: $1,500.
Prerequisite(s): APSC 3524
Instructional Contact Hours: (4 Lab, 1 Crd)

APSC 3684 - Special Topics in Animal and Poultry Sciences (1,2 credits)
An advanced, variable-content course which explores a topic in the animal sciences such as a significant contemporary issue; an emerging research area of interest to undergraduates; or a semester-long project involving a small group of students. May be repeated for up to three credits, no more than two credits per term.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1,2 Lec, 1,2 Crd)
Repeatability: up to 3 credit hours

APSC 3754 - Principles of Livestock Evaluation (2 credits)
Selection of market and breeding animals based on subjective and objective methods of evaluation. Basic understanding of evaluation principles, form-to-function, expected progeny differences, and performance records of beef cattle, swine, and sheep. Involves accurate decision making and oral reason presentations.
Prerequisite(s): APSC 1454
Instructional Contact Hours: (6 Lab, 2 Crd)

APSC 3764 - Livestock Merchandising (2 credits)
A comprehensive study of the principles and activities involved in successfully promoting and merchandising livestock. A livestock auction (Hokie Harvest Sale) is held at the conclusion of the course to provide experiences in advertising, salesmanship, livestock photography, facility development, sale management, and budgeting. Pre: Junior standing or consent.
Instructional Contact Hours: (2 Lec, 2 Crd)

APSC 3824 - Equine Training and Marketing (2 credits)
Application of fundamental behavioral concepts and principles to the training of horses in routine handling and groundwork. Preparation, marketing and presentation of horses for show and sale.
Prerequisite(s): APSC 2124
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

APSC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4004 - Contemporary Issues in the Animal Sciences (3 credits)
Applying critical thinking, ethical reasoning and problem solving in order to make ethical decisions in regard to important contemporary issues in animal agriculture and other areas of the animal sciences; discourse through oral and written communication.
Prerequisite(s): APSC 2004
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4054 - Genomics (3 credits)
A contemporary analysis of the development, utility and application of high-resolution methods for the study and manipulation of the complete genomes of organisms. The use of new techniques for genomic, metabolic and protein engineering (functional genomics), including high-throughput methods and nanotechnology, will be emphasized.
Prerequisite(s): BCHM 3114 or BCHM 4116 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BCHM 4054

APSC 4064 - Issues in Companion Animal Management (3 credits)
Comparative aspects of companion animals including physiology, anatomy, nutrition, genetics, reproduction and well-being. Normal and aberrant behaviors along with techniques of behavior modification and pharmacological intervention. Critical evaluation of current legal and ethical issues in the companion animal industry. Limited to dogs, cats and caged birds. Pre-requisite: Junior Standing required Pre-requisites may be waived with permission of instructor.
Prerequisite(s): APSC 2464 and ALS 3104 and ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4124 - Equine Health and Disease (4 credits)
Application of principles needed to effectively monitor and manage equine herd health. Focus on information synthesis, situation assessment and decision-making skills to develop preventative care protocols and treat illness. Practical application of horse health care techniques for routine and minor emergency situations.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

APSC 4204 - Advanced Equine Nutrition and Feeding (3 credits)
Analysis, formulation, and improvement of diets fed to horses in different physiological stages and metabolic statuses. Nutrient digestion, absorption, and utilization of nutrients. Computer-based ration formulation for horses. Applying economic principles to ration formulation and communicate equine nutrition concepts.
Prerequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4224 - Equine Exercise Physiology (3 credits)
Comprehensive study of conditioning the equine athlete using the principles of exercise physiology, energetics, kinetics, and sports medicine. Anatomy and physiology as it relates to exercise, conditioning and fitness assessment; exercise intolerance; performance nutrition; and medical practices used to support equine athletics.
Prerequisite(s): ALS 2304 and APSC 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4264 - Companion and Exotic Animal Nutrition (3 credits)
Idiosyncrasies and conformities of digestive systems and metabolic characteristics of cats, dogs, reptiles, small mammals, birds, and fish. Nutrient requirements by life-stage of cats, dogs, reptiles, small mammals, birds, and fish. Food ingredients, software-based pet food formulations, pet food labels, and regulatory frameworks. Modifications of pet food formulations for life stage and physiological conditions. Attributes of food ingredients that impact quality and nutritional value. Pet food packaging nutritional claims. Evaluation of newly emerging information and scientific literature regarding nutritional requirements of cats, dogs, reptiles, small mammals, birds, and fish.
Prerequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4304 - Principles and Practices of Bovine Reproduction (2 credits)
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, uterus and ovary condition. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: DASC 4304

APSC 4324 - Equine Reproduction and Neonatal Care (4 credits)
Principles and techniques in equine reproductive physiology and endocrinology. In-depth examination of equine reproduction strategies combined with practical techniques leading to synthesis and evaluation of breeding decisions. Anatomy and physiology of the mare and stallion, estrus detection and manipulation, artificial insemination, semen handling and processing, parturition and early care of neonates will be covered. Other topics will include selection of breeding stock and mating decisions.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

APSC 4404 - Commercial Poultry Enterprise Management (4 credits)
Production, management, and reproduction of meat- and egg-type chickens and turkeys. Emphasis is on the application of basic poultry science principles as they relate to commercial poultry enterprises. Advanced topics of economic analysis, program management, and problem solving used in decision making processes in integrated poultry operations.
Prerequisite(s): APSC 2104 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4414 - Beef and Sheep Production and Industry (4 credits)
Study of the commercial and purebred beef cattle and sheep industries. Principles and applications for successful and profitable beef and sheep production.
Prerequisite(s): APSC 2114 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4424 - Horse Production and Management (4 credits)
Reproduction, genetics, nutrition, herd health, planning and economics of private and commercial horse farms, and current issues in the horse industry.
Prerequisite(s): APSC 2124 and APSC 2424 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

APSC 4444 - Swine Production (3 credits)
Principles for commercial and seedstock swine production; current management practices, housing and marketing; issues and challenges in the swine industry. Experience in husbandry, research, and other management techniques obtained during laboratory.
Prerequisite(s): APSC 2114 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

APSC 4464 - Companion and Laboratory Animal Health and Management (4 credits)
Animal health, management, well-being, and government regulation in the maintenance, use and enjoyment of companion and laboratory animals.
Prerequisite(s): APSC 2164 and APSC 3064 and ALS 3104 and ALS 3204 and ALS 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

APSC 4514 - Animal Growth and Development (3 credits)
Meat animal growth and development processes, micro and gross anatomy, stem cell biology and growth, body and carcass composition with application to animal and carcass evaluation.
Prerequisite(s): ALS 2304 and ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4554 - Advanced Livestock Enterprise Management (3 credits)
Application of principles needed to manage profitable and sustainable beef cattle, sheep, and swine enterprises. Use of techniques to develop and evaluate strategies resulting in sound livestock enterprise management decisions. Focus on advanced animal management protocols, enterprise analysis, resource allocation, marketing options and risk management.
Prerequisite(s): APSC 4414 or APSC 4444
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

APSC 4624 - Topics in Equine Science (2 credits)
Review and critique of scientific literature related to equine science. Focus on creative and critical thinking. Principles and practice of information analysis, synthesis and evaluation through discourse and technical writing. Practical application of research and communication skills.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 2 Crd)

APSC 4774 - Nutrition and the Animal Brain (3 credits)
Relationship of diet and nutrients to animal behavior and neurobiology. Nervous system control of feeding behavior and metabolism to regulate whole body energy homeostasis in companion, livestock, and poultry species. Interactions of dietary formulations and nutrients affecting brain physiology and pathology.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

APSC 4954 - Capstone Experience in Animal and Poultry Sciences (1-19 credits)
Student-defined learning experience that utilizes knowledge and skills already learned to acquire new skills, synthesize information and solve problems in the animal sciences. Requires approval from the department before commencement of the experience, and a final report at its conclusion. Open to APSC majors only. Completion of 75 credits towards the APSC degree required.
Prerequisite(s): APSC 2004
Instructional Contact Hours: Variable credit course

APSC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APSC 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (DASC)

DASC 1464 - Dairy Cattle Handling (1 credit)
Safety in dairy cattle handling; animal behavior; care, housing, and managerial practices related to dairy cattle. Experiential activities. Herding, sorting, halter training, health scoring, and milking.
Instructional Contact Hours: (3 Lab, 1 Crd)

DASC 1574 - Dairy Science First Year Experience (1 credit)
The scope of the dairy science undergraduate program, preparation for careers in dairy and related industries. Hands-on experience working with dairy cattle. Inquiry, problem solving, and integration of ideas and experiences with a focus on the dairy industry.
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 2204 - Entrepreneurship in Animal Agriculture (3 credits)
Impact of animal entrepreneurship on the US agricultural economy. Innovative products and services for the dairy and livestock industries. Strategic planning, human resources, production scheduling, marketing, and financial management for animal enterprises. Capital acquisition. Sensitivity analysis for key planning assumptions. Contingency planning and risk management. Identification of non-traditional career paths in the animal industry. Pre: Sophomore Standing.
Prerequisite(s): AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 2474 - Dairy Science and Industry (3 credits)
Sustainable production, processing, and marketing of milk and milk products domestically and globally. Biology of dairy cattle with emphasis on genetics, reproduction, lactation, and nutrition. Management of dairy herds.
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 2484 - Dairy Cattle Evaluation (2 credits)
Critical appraisal of dairy cattle conformation and experience in linear trait scoring, linear trait relationships to profitability, competitive judging; written and oral justification; organization and conduct of shows and contests; showmanship. II.
Instructional Contact Hours: (6 Lab, 2 Crd)

DASC 2664 - Professional Discourse and Career Development (1 credit)
Emphasis on writing and speaking skills for livestock industry or post-baccalaureate education. Self-marketing, job acquisition, press relations, and conduct of meetings and labor management techniques.
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 3134 - Animal Agriculture and the Environment (3 credits)
Environmental issue associated with animal agriculture. Nutrient contamination of water resources, odor emission from livestock farms, environmental regulations affecting animal agriculture, and management practices to reduce the impacts of livestock farms on air and water quality.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APSC 3134

DASC 3274 - Applied Dairy Cattle Nutrition (3 credits)
Application of basic principles of nutrition in developing rations for dairy herds. Emphasis is placed on appropriate use of forages, ration formulation techniques, development of profitable rations, and ration delivery.
Corequisite(s): ALS 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 3474 - Dairy Information Systems (3 credits)
Development, function, and use of dairy information systems including computerized performance testing programs for dairy cattle improvement and dairy herd management. Dairy management software applications. Precision dairy farming. Whole herd evaluation. Pre: Junior standing.
Prerequisite(s): DASC 2474
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4174 - Applied Dairy Cattle Genetics (3 credits)
Application of genetic principles to dairy cattle improvement. Setting goals for genetic improvement, characteristics of traits included in selection, current methods of estimating breeding values, the role of artificial insemination and breed associations in genetic improvement, cattle genetics.
Prerequisite(s): ALS 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4274 - Dairy Ration Formulation (1 credit)
Develop entry level professional animal nutritionist skills; use customer and feed databases, use optimization algorithms to formulate least cost diets and feed mixes, simultaneous consideration of diet cost, animal product return, and environmental constraints; further develop intergrative thinking and problem solving skills.
Corequisite(s): DASC 3274
Instructional Contact Hours: (0 Lec, 3 Lab, 1 Crd)

DASC 4304 - Principles and Practices of Bovine Reproduction (2 credits)
Principles and techniques in reproductive physiology and herd management related to health, record keeping, estrus detection and synchronization, and ultrasonography. Ovarian function and superovulation, semen handling, artificial insemination and pregnancy detection are also considered.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: APSC 4304

DASC 4374 - Physiology of Lactation (3 credits)
Anatomy of the mammary gland and physiology of lactation in domestic and laboratory mammals with emphasis on dairy cattle. Mammary gland health and factors affecting lactation. Principles and techniques in dairy herd milking management.
Prerequisite(s): ALS 2304
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 4384 - Mammary Immunology (3 credits)
This course is designed to provide students with basic knowledge of immunology as related to diseases of the mammary gland. Concepts of mammary gland immunity, disease etiology, immunopathology, diagnosis and therapy will be covered with a focus on ungulate species. Host pathogen interactions, solving problems, writing intensive, literature search.
Prerequisite(s): ALS 2304 and ENGL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4474 - Advanced Dairy Management Evaluation (2 credits)
Students will learn to critically evaluate all aspects of dairy farm management on working farms. The assessment and recommendations will be developed using information gathered from herd production records and financial statements, visual observations at the farm, and an interview of the farm owner and workers. Data assessed will include milk, growth, health, reproduction, and culling records; cash flow and profit loss statements; nutrition and nutrient management records; and labor management structure. The assessments and reports will further develop integrative thinking, oral communication, and written communication skills.
Prerequisite(s): DASC 3474 and ALS 3204 and ALS 3304
Corequisite(s): DASC 4475
Instructional Contact Hours: (6 Lec, 0 Lab, 2 Crd)

DASC 4475 - Dairy Enterprise Management (3 credits)
Decision strategies for modern dairy businesses. 4475: Emphasis on relationships of enterprises and techniques for evaluation of business alternatives, efficiency of production, and profit. Use of microcomputer software to support management decisions. 4476: Concentration on herd replacements, personnel, facilities and issues of management associated with rapidly changing national and international markets, environmental regulations, and computer applications. Group projects and hands-on management of university dairy herd.
Prerequisite(s): DASC 2474
Instructional Contact Hours: (3 Lec, 3 Crd)

DASC 4476 - Dairy Enterprise Management (3 credits)
Decision strategies for modern dairy businesses. 4475: Emphasis on relationships of enterprises and techniques for evaluation of business alternatives, efficiency of production, and profit. Use of microcomputer software to support management decision. 4476: Concentration on herd replacements, personnel, facilities and issues of management associated with rapidly changing national and international markets, environmental regulations, and computer applications. Group projects and hands-on management of university dairy herd. Pre-requisite may be waived with permission of instructor.
Prerequisite(s): (DASC 4475 or AAEC 3454) and DASC 3474
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

DASC 4664 - Translating Dairy Science (1 credit)
Analysis and interpretation of peer-reviewed literature in dairy science. Focus on dairy industry issues discussed in social media. Critical reasoning, information synthesis, and oral and written discourse. Paper presentations and discussion. Pre: Senior Standing
Prerequisite(s): DASC 2664
Instructional Contact Hours: (1 Lec, 1 Crd)

DASC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

DASC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Animal and Poultry Sciences Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
APSC 1454	Introduction to Animal and Poultry Science (C) [1]	3
APSC 1464	Animal and Poultry Science Laboratory [1]	1
APSC 1504	Animal and Poultry Sciences First Year Experience [1]	1
APSC 2004	Animal and Poultry Sciences Seminar [1]	1
ALS 2304	Comparative Animal Physiology and Anatomy [1]	4
ALS 3204	Animal Nutrition and Feeding [1]	3
Subtotal		21
Major Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Economics Requirement		
Select one of the following:		3
AAEC 1006	Economics of the Food and Fiber System	
AAEC 2104	Personal Financial Planning	
AAEC 2434	Foundations of Agribusiness	
Experiential Learning Requirement		
Select one of the following:		1
APSC 4954	Capstone Experience in Animal and Poultry Sciences	
APSC 3954	Study Abroad (Approved on a case-by-case basis.)	
APSC 4964	Field Study (Approved on a case-by-case basis.)	
APSC 4974	Independent Study (Approved on a case-by-case basis.)	
APSC 4994	Undergraduate Research (Approved on a case-by-case basis.)	
3954, 4964, 4974, and 4994 courses hosted in other departments will be approved on a case by case basis.		
Species Requirement [1,2]		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select one of the following:		3
APSC 3504	Poultry Science and Health	
APSC 3064	Companion and Laboratory Animal Science	
APSC 4404	Commercial Poultry Enterprise Management	
APSC 4414	Beef and Sheep Production and Industry	
APSC 4424	Horse Production and Management	
APSC 4444	Swine Production	
APSC 4464	Companion and Laboratory Animal Health and Management	
Animal Science/Management Requirement [1,2]		

Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select four of the following. At least 12 credits total.		12
ALS 3304	Physiology of Reproduction	
ALS 4554	Neurochemical Regulation	
ALS 4574	Social Behavior of Birds and Mammals	
APSC 3134	Animal Agriculture and the Environment	
APSC 3214	Principles of Meat Science	
APSC 3254	Animal Products	
APSC 3334	Animal Welfare and Bioethics	
APSC 3434	Host Microbe Interactions	
APSC 3504	Poultry Science and Health	
APSC 3064	Companion and Laboratory Animal Science	
APSC 4054	Genomics	
APSC 4124	Equine Health and Disease	
APSC 4204	Advanced Equine Nutrition and Feeding	
APSC 4224	Equine Exercise Physiology	
APSC 4324	Equine Reproduction and Neonatal Care	
APSC 4404	Commercial Poultry Enterprise Management	
APSC 4414	Beef and Sheep Production and Industry	
APSC 4424	Horse Production and Management	
APSC 4444	Swine Production	
APSC 4464	Companion and Laboratory Animal Health and Management	
APSC 4514	Animal Growth and Development	
APSC 4554	Advanced Livestock Enterprise Management	
DASC 3274	Applied Dairy Cattle Nutrition	
DASC 3474	Dairy Information Systems	
DASC 4174	Applied Dairy Cattle Genetics	
DASC 4374	Physiology of Lactation	
DASC 4384	Mammary Immunology	
DASC 4475	Dairy Enterprise Management	
DASC 4476	Dairy Enterprise Management	
Subtotal		19
Elective Courses		
Restricted Electives [3,4]		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Take 21 credits from the following list.		21
AAEC 2104	Personal Financial Planning	
AAEC 2434	Foundations of Agribusiness	
AAEC 3XXX and higher		
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
AHRM 2404	Consumer Rights	
ALCE 3XXX and higher		
ALS 2XXX and higher		
APSC 2XXX and higher		
BCHM 2XXX and higher		
BIOL 2XXX and higher except 3404		
BIT 2XXX and higher		
BMVS 4XXX (except 4054 and 4064)		
BSE 2XXX and higher		
CHEM 2XXX and higher		
COMM 2XXX and higher		
CONS 2304	Consumer and Family Finances	
CSES 2XXX and higher		
DASC 2XXX and higher		
ECON 2XXX and higher		
ENGL 3774	Business Writing	
or ENGL 3764	Technical Writing	
ENSC 3XXX		
ENT 2XXX and higher		
FIN 3XXX and higher		
FIW 2XXX and higher		
FST 2XXX and higher		
GEOG 4XXX		
HNFE 1004	Foods, Nutrition And Exercise	
HNFE 2XXX and higher		
HORT 2XXX and higher		
HTM 2XXX and higher		
IS 2XXX and higher		
MATH 1025	Elementary Calculus (and higher)	
MGT 3XXX and higher		
MKTG 3XXX and higher		
NEUR 2XXX and higher		
PHS 4XXX		
PHYS 2XXX and higher (except 2074, 2325, 2326)		
PPWS 2XXX and higher		
PSYC 2074	Animal Behavior	
STAT 3XXX and higher		
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 2244	World Crops: Food and Culture	
Free Electives		
Select credit hours to fulfill degree requirement.		12
Subtotal		33
Pathways to General Education [5]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
APSC 4004	Contemporary Issues in the Animal Sciences (1A) [1]	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select an additional three credit hours of Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		

MATH 1014	Precalculus with Transcendental Functions (5F)	3
or MATH 1025	Elementary Calculus	
STAT 2004	Introductory Statistics (5F)	3
or STAT 3005	Statistical Methods	
ALS 3104	Animal Breeding and Genetics (5A) [1]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) and three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) or six credits in integrated arts and design.		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) Students may have 3 more credits of free electives by choosing a course that double counts for Pathways 7 and Pathways 2, Pathways 3, or Pathways 6.		3
Subtotal		47
Total Credits		**120**

1. These courses are included in the in-major GPA calculation and must be taken A-F unless offered P-F only.
2. At least 6 credits of Species and/or Animal Science/Management courses must be 4XXX. Cannot double count courses in Species Requirement and Animal Science/Management Requirement.
3. All restricted electives must be taken on an A-F basis, unless only offered P/F. Only free electives may be taken P/F if offered A-F. At least 6 credits of approved restricted electives must be 4XXX. 1984, 2964, 2974, 2984, 2994, 3954, 3964, 3984, 4964, 4974, 4984, and 4994 courses will be considered on a case-by-case basis. Courses used for Major Requirements cannot double count as Restricted Electives or Free Electives. Enrollment in specific courses listed as Restricted Electives is not guaranteed. Consult with your advisor when choosing restricted electives.
4. APSC majors completing a foreign language minor may use up to 6 credits of 3xxx or 4xxx courses from the minor as restricted electives. APSC majors completing a Psychology minor may use 1 3XXX or 4XXX course towards their restricted electives if they also complete PSYC 2074.
5. Courses used for Pathways 1-7 or Degree Core cannot be used for Major Requirements, Restricted Electives, or Free Electives.

Upon the completion of 72 credits, APSC students must have completed CHEM 1036 General Chemistry, CHEM 1046 General Chemistry Laboratory, APSC 1454 Introduction to Animal and Poultry Science, APSC 1464 Animal and Poultry Science Laboratory, and 6 credits from ALS 2304 Comparative Animal Physiology and Anatomy, ALS 3104 Animal Breeding and Genetics, or ALS 3204 Animal Nutrition and Feeding; have a minimum overall GPA of 2.00; and have completed at least 24 credits that apply to the Pathway to General Education requirements.

Graduation Requirements

Students must complete the courses listed to equal at least 120 credits, with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00.

For purposes of GPA computation, courses included in the calculation of **in major** GPA are courses notated with the applicable footnote.

An APSC degree may be earned in combination with the first year of work in an accredited medical, dental, or veterinary school, provided that the following requirements are met: at least two of the three years of pre-professional work, including the third year, are in residence at VT; a minimum of 90 semester credits of undergraduate work that include all the courses listed above as Pathway to General Education and Degree Core, and at least one course listed under the Species Requirement.

Students majoring in Animal and Poultry Sciences cannot minor in Animal and Poultry Sciences or in Equine Sciences.

Foreign Language Requirements

Four credits of accelerated foreign language or two semesters of a single foreign language are required unless 2 units of a single foreign language are completed in high school. These credits do not count toward graduation requirements.

Dairy Science Major with Dairy Business Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
CHEM 1015 & CHEM 1016	Chemistry in Context and Chemistry in Context	6
or CHEM 1035 & CHEM 1036	General Chemistry and General Chemistry	
ALS 2304	Comparative Animal Physiology and Anatomy [1]	4
ALS 3204	Animal Nutrition and Feeding [1]	3
ALS 3304	Physiology of Reproduction [1]	3
DASC 2474	Dairy Science and Industry [1]	3
DASC 2664	Professional Discourse and Career Development [1]	1
DASC 3474	Dairy Information Systems [1]	3
DASC 4374	Physiology of Lactation [1]	3
DASC 4664	Translating Dairy Science [1]	1
Subtotal		27
Option Required Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
DASC 4475	Dairy Enterprise Management [1]	3
DASC 4476	Dairy Enterprise Management [1]	3
Select one of the following:		3
DASC/APSC 3134	Animal Agriculture and the Environment [1,2]	
DASC 3274	Applied Dairy Cattle Nutrition [1,2]	
DASC 4174	Applied Dairy Cattle Genetics [1,2]	
Subtotal		9
Dairy Elective Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select at least eight credits from the following:		8
DASC 1464	Dairy Cattle Handling [1]	
DASC 1574	Dairy Science First Year Experience [1]	

DASC 2204	Entrepreneurship in Animal Agriculture [1]	
DASC 2484	Dairy Cattle Evaluation [1]	
DASC/APSC 3134	Animal Agriculture and the Environment [1,2]	
DASC 3274	Applied Dairy Cattle Nutrition [1,2]	
DASC 4174	Applied Dairy Cattle Genetics [1,2]	
DASC 4274	Dairy Ration Formulation [1]	
DASC/APSC 4304	Principles and Practices of Bovine Reproduction [1]	
DASC 4384	Mammary Immunology [1]	
DASC 4474	Advanced Dairy Management Evaluation [1]	
DASC 4964	Field Study [1,3,4]	
or DASC 497	Independent Study	
or DASC 499	Undergraduate Research	
Subtotal		8
Option Business Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select at least nine credits from the following that have not been used to satisfy Pathway requirements:		9
AAEC	Any	
ACIS	Any	
ECON	Any	
FIN	Any	
MGT	Any	
MKTG	Any	
Option Restricted Electives [4]		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select at least 12 credits from the following:		12
Any courses not already used to fullfill other degree requirements.		
AAEC	Any	
ACIS	Any	
ALS	Any	
APSC	Any	
BCHM	Any	
BIOL	Any	
BMVS	With advisor approval	
BSE	Any	
CHEM	Any	
COMM	Any	
CS	Any	
CSES	Any	
DASC	Any	
ECON	Any	
ENT	Any	
FIW	Any	
FOR	Any	
FST	Any	
HNFE	Any	
HORT	Any	
MATH	Any	
MGT	Any	
MKTG	Any	
PHYS	Any	
SPAN	Any	
STAT	Any	
Subtotal		21
Free Electives		
Select credits needed to complete 120 credits		8
Subtotal		8
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
ENGL 1106	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		3
MATH 1014	Precalculus with Transcendental Functions	
MATH 1025	Elementary Calculus	
MATH 1225	Calculus of a Single Variable	
Select one of the following:		3
STAT 2004	Introductory Statistics (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	
STAT 3005	Statistical Methods	
STAT 3615	Biological Statistics	
ALS 3104	Animal Breeding and Genetics (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)) [1]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3

Students may have 3 more credits of free electives by choosing a course that doublecounts for Pathways 7 and Pathways 2, Pathways 3, or Pathways 6.	
Subtotal	47
Total Credits	**120**

1 Courses used for calculation of in-major GPA requirement.
2 These courses (DASC/APSC 3134, DASC 3274, DASC 4174) can be used to meet Option requirements or count toward Dairy Electives, but not both.
3 A maximum of 3 credits may be used from a combination of DASC 4964, 4974, and 4994.
4 Courses from the list of approved Option Restricted Electives cannot be double counted for Pathways to General Education, Dairy Science Common Degree Core, Option Dairy Requirements, Dairy Electives, or Option Business Requirements.

1. After completion of 30 Virginia Tech semester credits: 3 semester credits of DASC courses
2. After completion of 36 semester credits, including credits completed at Virginia Tech, transfer credits, advanced placement & standing, credit by exam, and course withdrawal: 12 semester credits in any area of the Pathways to General Education
3. After completion of 72 semester, credits including credits completed at Virginia Tech, transfer credits, advanced placement & standing, credit by exam, and course withdrawal: 24 semester credits in any area of the Pathways to General Education, 6 semester credits of DASC courses; at least 9 semester credits of in-major courses
4. After 96 semester credits: In-major GPA of at least 2.00, Overall GPA of at least 2.00

Graduation Requirements

A 2.00 minimum overall and in-major GPA is required for graduation. Minimum DASC Credits Required for Graduation: 20. Total Credits Required for Graduation: 120.

Foreign Language Requirements

Four credits of accelerated foreign language or two semesters of a single foreign language are required unless 2 units of a single foreign language are completed in high school. These credits do not count toward graduation requirements.

Dairy Science Major with Science/ Prevet Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
CHEM 1015 & CHEM 1016	Chemistry in Context and Chemistry in Context	6
or CHEM 1035 & CHEM 1036	General Chemistry and General Chemistry	
ALS 2304	Comparative Animal Physiology and Anatomy [1]	4
ALS 3204	Animal Nutrition and Feeding [1]	3
ALS 3304	Physiology of Reproduction [1]	3
DASC 2474	Dairy Science and Industry [1]	3
DASC 2664	Professional Discourse and Career Development [1]	1
DASC 3474	Dairy Information Systems [1]	3
DASC 4374	Physiology of Lactation [1]	3
DASC 4664	Translating Dairy Science [1]	1
Subtotal		27
Dairy Elective Courses		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select a minimum of nine credits from the following:		9
DASC 1464	Dairy Cattle Handling [1]	
DASC 1574	Dairy Science First Year Experience [1]	
DASC 2204	Entrepreneurship in Animal Agriculture [1]	
DASC 2484	Dairy Cattle Evaluation [1]	
DASC/APSC 3134	Animal Agriculture and the Environment [1]	
DASC 3274	Applied Dairy Cattle Nutrition [1]	
DASC 4174	Applied Dairy Cattle Genetics [1]	
DASC 4274	Dairy Ration Formulation [1]	
DASC/APSC 4304	Principles and Practices of Bovine Reproduction [1]	
DASC 4384	Mammary Immunology [1]	
DASC 4474	Advanced Dairy Management Evaluation [1]	
DASC 4475	Dairy Enterprise Management [1]	
DASC 4476	Dairy Enterprise Management [1]	
DASC 4974	Independent Study [1,2,3]	
or DASC 4994	Undergraduate Research	
Subtotal		9
Option Science / Pre-Vet Requirements		
Many courses in this list have prerequisites. Click on each course for its description and any co- or prerequisites.		
Select one of the following:		2
CHEM 1025 & CHEM 1026	Introduction to Chemistry Laboratory and Introduction to Chemistry Laboratory	
CHEM 1045 & CHEM 1046	General Chemistry Laboratory and General Chemistry Laboratory	
Select at least 23 credits from the following:		23
APSC 3434	Host Microbe Interactions	
BCHM 2024	Concepts of Biochemistry	
BCHM 3XXX, 4XXX	**Any** BCHM at the 3000 level or higher	
BIOL 2XXX, 3XXX, 4XXX	**Any** Biology at the 2000 level or higher	
CHEM 2XXX, 3XXX, 4XXX	**Any** Chemistry at the 2000 level or higher	
PHYS 2205	General Physics	
PHYS 2206	General Physics	
PHYS 2215	General Physics Laboratory	
PHYS 2216	General Physics Laboratory	
DASC 4994	Undergraduate Research [1,3]	
Subtotal		25
Free Electives		
Select credits needed to complete 120 credits		12

Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select 3 credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		3
MATH 1014	Precalculus with Transcendental Functions (5F)	
MATH 1025	Elementary Calculus (5F)	
MATH 1225	Calculus of a Single Variable (5F)	
Select one of the following:		3
STAT 2004	Introductory Statistics (5F)	
STAT 3005	Statistical Methods (5F)	
STAT 3615	Biological Statistics (5F)	
ALS 3104	Animal Breeding and Genetics (5A) [1]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Students may have 3 more credits of free electives by choosing a course that double counts for Pathways 7 and 2, Pathways 3, or Pathways 6.		
Subtotal		47
Total Credits		**120**

[1] These courses are included in the in-major GPA calculation.

[2] A maximum of 3 credits may be used from a combination of DASC 4974 and DASC 4994.

[3] DASC 4994 can be used to meet Option requirements or count toward Dairy Electives, but not both.

1. After completion of 30 Virginia Tech semester credits: 3 semester credits of DASC courses
2. After completion of 36 semester credits, including credits completed at Virginia Tech, transfer credits, advanced placement & standing, credit by exam, and course withdrawal: 12 semester credits in any area of the Pathways to General Education
3. After completion of 72 semester credits, including credits completed at Virginia Tech, transfer credits, advanced placement & standing, credit by exam, and course withdrawal: 24 semester credits in any area of the Pathways to General Education, 6 semester credits of DASC courses; at least 9 semester credits of in-major courses
4. After 96 semester credits: In-major GPA of at least 2.00, Overall GPA of at least 2.00

Graduation Requirements

A 2.00 minimum overall and in-major GPA is required for graduation. Minimum DASC Credits Required for Graduation: 20. Total Credits Required for Graduation: 120

Foreign Language Requirements

Four credits of accelerated foreign language or two semesters of a single foreign language are required unless 2 units of a single foreign language are completed in high school. These credits do not count toward graduation requirements.

School of Plant and Environmental Sciences

Our Website (http://www.spes.vt.edu)

Overview

The School of Plant and Environmental Sciences increases the University's capacity to tackle challenges in agriculture and food security, the green industry, plant biology, and the environment. Currently, the School offers two undergraduate degrees and seven majors: 1) Crop and Soil Sciences, 2) Ecological Restoration, 3) Environmental Horticulture, 4) Environmental Science, 5) Integrated Agriculture Technologies, 6) Landscape Design and Turfgrass Science, and 7) Plant Science.

Degree Programs

Environmental Science

The Environmental Science degree program brings the basic sciences to bear on many crucial concerns about the environment. The environments of particular interest are terrestrial and wetland ecosystems and associated land and water resources. Specific concerns include environmental protection, pollution prevention and remediation, land-use planning, waste management, ground- and surface-water quality, reclamation and remediation of disturbed or contaminated sites, and minimizing human impacts on the environment.

Plant Science

The Plant Science degree program trains students to improve the productivity, utilization, and sustainability of plants grown for human use. Students obtain a thorough education in the applied plant sciences related to the major disciplinary areas in our School - Crop and Soil Sciences, Environmental Horticulture, Landscape Design and Turfgrass Science, and Plant Science.

Majors

Crop and Soil Sciences

Crop and Soil Sciences major prepares students for graduate school and crop-related management careers in the private and public sectors.

Students in this major learn the principles of crop production, soil science, nutrient management, and pest management to improve the productivity of large-scale field crops while protecting the environment.

Ecological Restoration

Ecological Restoration is the process of guiding the recovery of degraded or destroyed ecosystems in agricultural, urban, and mined landscapes and associated waters. Students in the Ecological Restoration major engage in a structured program of learning that moves from introductory courses in the biological and physical sciences to courses in soil science, ecology, geology, plant science, and ecological restoration. The curriculum accommodates both in-class and field-based learning and was designed in conjunction with the Society for Ecological Restoration's Certified Ecological Restoration Practitioner In-Training program (CERPIT).

Environmental Horticulture

Horticulture is an applied plant science that covers the study of ornamental plants, floriculture, and intensively managed crops like fruits and vegetables. In addition to plant science, students also learn about principles of greenhouse management and other controlled environmental agriculture systems (e.g., vertical farming). The program covers a range of applied and basic environmental plant science topics, from plant-soil interactions, biotechnology, landscape design, sustainable urban landscaping, urban forestry, crop production, and plant breeding.

Environmental Science

The Environmental Science curriculum is multidisciplinary and strongly science and technology oriented. Students learn about preserving, protecting, and remediating resources and the ecosystems that provide them. Our rigorous program has established an excellent reputation among employers and our graduates are in great demand primarily working in environmental engineering fields, environmental consulting, and various governmental agencies.

Integrated Agriculture Technologies

The Integrated Agriculture Technologies major seeks to prepare a new generation of students that will work in the applied plant sciences using advanced technologies to improve plant productivity and protecting the environment. Students learn to work with drones, robots, environmental sensors, satellite imaging, and data analytics to improve the sustainability field crops and horticultural systems. Students in the major gain a unique combination of technological know-how and extensive practical knowledge in the plant and soil sciences.

Landscape Design and Turfgrass Science

Landscape Design and Turfgrass Science major learn to design, build, and manage beautiful and functional landscapes using science-based practices that improve the living environment and contribute to environmental sustainability. Students choose a concentration area that best meets their chosen career path- Landscape Design or Turfgrass Management. Students in the Landscape Design concentration learn principles related to the design, installation, and maintenance of different types of landscapes in the public and private sectors. Students working in Turfgrass Management concentration learn principles related to the care and management of lawns, landscapes, golf courses, and athletic fields.

Plant Science

The Plant Science major prepares students for graduate school and careers in the private and public sectors working in the fields of plant breeding, biotechnology, plant pathology, and weed science. Students learn principles of plant biology, molecular biology, biochemistry, plant genetics, and crop breeding and apply these to better understand how to improve plant productivity and sustainability.

Minors

The School offers minors in Crop and Soil Environmental Sciences, Environmental Science, Horticulture, Plant Health Sciences, Turfgrass Management, Viticulture, and Wetland Science. The course requirements for each vary and include a required course (s) plus 15 or 16 more credit hours selected from courses from within and outside the department. Consult the department office (330 Smyth) or website at http://registrar.vt.edu/graduation-multi-brief/index1.html for more information on a minor.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the specific degree can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

Opportunities to Excel

Students with outstanding records can qualify for the Honors Program and graduate "in honors" in crop and soil environmental sciences. Other opportunities for personal and professional growth and for recognition include Agronomy Club, Environmental Student Organization, Horticulture Club, and Turf Club. Membership in Alpha Zeta, Gamma Sigma Delta, Pi Alpha Xi or other honoraries, and several scholarships are also available. Many students participate in internships that are commonly available in the respective disciplines.

Graduate courses and research opportunities lead to M.S. and Ph.D. specializations in the Crop, Soil, and Environmental Sciences, Horticulture, and Plant Pathology and Weed Science. (See the Graduate Catalog (https://catalog.vt.edu/graduate/) for more information.)

- Crop and Soil Sciences Major (p. 567)
- Ecological Restoration Major (p. 569)
- Environmental Horticulture Major (p. 572)
- Environmental Science Major (p. 574)
- Integrated Agriculture Technologies Major (p. 576)
- Landscape Design and Turfgrass Science Major (p. 578)
- Plant Science Major (p. 581)

Head: Michael Evans
Associate Director for Undergraduate Programs: Benjamin Tracy (231.8259, bftracy@vt.edu)
Professors: A. O. Abaye, E. Beers, J. F. Derr, M. J. Eick, J. D. Eisenback, G. K. Evanylo, J. H. Fike, J. M. Goatley Jr., C. Hong, C. S. Johnson, D.B. Langston Jr, R. O. Maguire, J. M. McDowell, A. Niemiera, M. A. Saghai Maroof, D. G. Schmale III, T. Thompson, B. F. Tracy, B. A. Vinatzer, G. Welbaum, J. H. Westwood, M. Williams, K. Xia
Associate Professors: S. D. Askew, B. D. Badgley, M. Balota, J. N. Barney, A. B. Baudoin, E. Colláková, M. L. Flessner, W. H. Frame, J. M. Galbraith, D. Holshouser, J. G. Jelesko, S. Li, G. Pilot, M.S. Reiter, S. L. Rideout, R. Stewart, X. Wang, C. A. Wilkinson, and B. Zhao

Assistant Professors: B. Bargmann, P. Brown, D. C. Haak, D. S. McCall, M. Nita, B.B. Posadas, A. Possinger, J. L. Reid, J. Samtani, D. Sandor, N. Santantonio, H. Seyyedhasani, S. Shafian, S. Sherif, V. Singh, K. South, M. Steele, and B. Zhang
Affiliate Professor: A. Pereira
Adjunct Professors: J. Atland, M. Chaungsheng, K. Da, Y. Dan, B. Flinn, R. F. Follett, Z. Liu, S. Lowman J. E. Perry III, P. J. Thomas, R. W. Tiner, M. J. Vepraskas, and S. Zhang
AP Faculty Professional: S. Douglas, J. Freeborn, S. Gugercin, L. Fox, A. Straw, and A. Vallotton
Instructors: J. Kardos, B. Leshyn, and L.R. Salamanca
Special Research Faculty: E. A. Bush, S. Y. Park, and E. Unglesbee

Undergraduate Course Descriptions (CSES)

CSES 2224 - Foundations of Precision Agriculture (3 credits)
Integrated technologies in the plant and environmental sciences including: global positioning systems (GPS), geographic information systems (GIS), remote and proximal sensing, variable rate technology (VRT) and decision support systems (DSS). Application to site-specific nutrient, water, weed and disease management.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2244 - Agriculture, Global Food Security and Health (3 credits)
Agriculture and food security within the larger context of applied agronomy, gender role, cultural and political aspects of food production, food policy, production contraints, and global population growth. Emphasis on gender iniquity and globalized food systems will be made. Service learning experience both local and global to promote career opportunity in international development.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2434 - Crop Evaluation (2 credits)
Identification of more than 200 crops, weeds, seeds and crop diseases. Seed testing for purity according to the rules of the Association of Official Seed Analysts. Crops graded according to the official USDA grain grading standards.
Instructional Contact Hours: (6 Lab, 2 Crd)

CSES 2444 - Agronomic Crops (3 credits)
An introduction to crop production in Virginia, presenting basic climatic, crop, and soil characteristics and their relation to cropping systems. Introduces basic mechanical, chemical, and managerial tools of crop production and examines feed quality and seed and forage storage.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 2564 - Turfgrass Management (3 credits)
Growth, development, adaptation, and selection of the major turfgrass species. Principles of establishment, mowing, nutrition, irrigation, cultivation, and pest control of lawns and utility turfs.
Corequisite(s): BIOL 1105
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3114 - Soils (3 credits)
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant-and earth-science majors. Partially duplicates 3134.
Prerequisite(s): CHEM 1036
Corequisite(s): CSES 3124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOS 3614

CSES 3124 - Soils Laboratory (1 credit)
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates 3134.
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: GEOS 3624

CSES 3144 - Soil Description and Interpretation (3 credits)
Describing, classifying, evaluating, and interpreting soil and site properties in the class and field. Local field trips supplement lecture and laboratory studies. Required for students interested in attending soil judging contests.
Corequisite(s): CSES 3114, CSES 3124
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

CSES 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3304, GEOS 3304

CSES 3564 - Golf and Sports Turf Management (3 credits)
Principles of turfgrass science and culture required for successful establishment and management of intensely utilized fine golf and sports turf surfaces. Pre: CSES 3564 or equivalent turfgrass science fundamentals course from transfer institution.
Prerequisite(s): CSES 2564
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3614 - Soil Physical and Hydrological Properties (3 credits)
Soil physical and mechanical properties and the physical processes controlling soil water retention and flow in agronomic and natural settings. Grain size distribution, weight-volume relationships, specific surface, electrical charge density, consistency, stress, compaction, rainfall runoff, water retention, steady/non-steady water flow in saturated/unsaturated soil, infiltration, bare soil evaporation, and soil water balance.
Prerequisite(s): (CSES 3114 and CSES 3124) or (GEOS 3614 and GEOS 3624)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4064 - Soil Microbiology (3 credits)
Soil microbes as determinants of plant growth, sustainable agricultural systems, and global nutrient cycles. Environmental controls of soil microbes and relationship to soil decomposition. Soil as a micro-habitat. Application to soil management and plant growth, plant-microbe mutualisms, probiotics, biocontrol, composting, ecosystem restoration, and disease suppression.
Prerequisite(s): BIOL 1105 and (CSES 3114 or ENSC 3114 or GEOS 3614) or (CSES 3134 or ENSC 3134)
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4134 - Soil Genesis and Classification (3 credits)
Formation of soils across landscapes, soil-forming factors and processes, applied soil geology/geomorphology, applied soil biochemistry, soil hydrology, diagnostic horizons and characteristics used in Soil Taxonomy; soil classification and mapping. Three outdoor lectures and one 3-day field trip are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4144 - Plant Breeding and Genetics (3 credits)
Genetic variation in plants and its importance in plant breeding, and comparisons of theories and procedures in breeding of self-pollinated versus cross-pollinated plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4174 - Soil Evaluation and Sampling (3 credits)
Naming, describing, classifying, sampling, and interpreting soil and site properties in the field to assess environmental impacts and suitability under specific land use scenarios. Selecting and evaluating sites of representative soil resources across the landscape using accepted professional protocols, simulating workplace responsibilities and performance. Local and regional field trips and sampling projects provide professional skill development evaluated by practitioners and potential employers.
Prerequisite(s): CSES 3114 or CSES 3144
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4214 - Soil Fertility and Management (3 credits)
Soil productivity and nutrients required for crop growth; fertilizer sources and nutrient reactions in soil; methods of fertilizer nutrient placement in major tillage systems; and interpretation of soil tests and plant analyses for determining crop nutrient requirements.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4224 - Applied Concepts in Precision Agriculture (3 credits)
Advanced applications of core components and technologies used for integrated plant and environmental studies. Global Navigation Satellite Systems (GNSS), remote sensing technologies, Geographic Information Systems (GIS), soil sampling, yield monitoring, and analysis and decision-making systems applied for site specific management of production agriculture resources.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4234 - Agro Data Integration (3 credits)
Data science applications in the agricultural sciences. Data pipelines and modern Linux, cluster and cloud-based computing environments. Command line interface and shell scripting. Programming and data processing in Python programming language. Data analysis and visualization in R programming language. Agronomic data analysis and data mining.
Prerequisite(s): CSES 2224 and CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4324 - Water Quality Laboratory (1 credit)
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314.
Prerequisite(s): CHEM 1046
Corequisite(s): CSES 4314, ENSC 4314
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ENSC 4324

CSES 4334 - Principles and Practice of Agroforestry (3 credits)
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4334

CSES 4344 - Crop Physiology and Ecology (3 credits)
Developmental and ecological processes important in cropping situations: seed physiology, root and canopy development, flowering, water stress, energy flow, competition; emphasis on physiological adaptations, limitations to yield, and yield-optimizing strategies.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4354 - Advanced Agronomic Crops (3 credits)
Survey of major agronomic crops grown in the Eastern US and their production including: corn, soybean, wheat, barley, cotton, peanut, tobacco and alfalfa. Covers impact of environmental conditions and management on crops, resource requirements for productivity, and effects on soil resources.
Prerequisite(s): CSES 2444
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4444 - Managed Ecosystems, Ecosystem Services, and Sustainability (3 credits)
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior Standing required.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENSC 4444

CSES 4524 - Drone Applications in Ag Systems (3 credits)
Unmanned Aerial Systems (UAS) or drones as an advanced remotely sensed technology to collect ultra-high spatial resolution images. Components of drones and sensors. UAS operational concepts, and legal requirements, principles of drone data collection and drone platforms. Overview of data processing software and generation of land maps from drone photogrammetry. Image analysis to make recommendations for water, nutrient and pesticide applications.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4534 - Internet of Things (IoT) for Smart Farming (3 credits)
Internet of Things (IoT) technology in the plant and environmental sciences and applications to smart-farming ecosystems and agricultural industry. IoT platforms and systems used in smart farming programs related to field equipment management, IoT components, data management, and cybersecurity. Applying wireless sensors, controllers, computers, actuators, and software via wireless network devices.
Prerequisite(s): CSES 2224
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4544 - Forage Crop Ecology (3 credits)
Species adaptation interrelated with soil, climatic, and biotic factors as associated with establishment, production, utilization, and nutritional value of forages.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4644 - Land-based Systems for Waste Treatment (3 credits)
Soils as a medium for waste treatment; potential for environmental degradation from biologicals and chemicals added to soils; development of land-based treatment and utilization systems for solid and liquid wastes; issues and concerns relating to large-scale applications of municipal and industrial wastes to land.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4854 - Wetland Soils and Mitigation (3 credits)
Wetland soils as components of natural landscapes: biogeochemistry, hydrology, geomorphology, hydric soil indicators, and wetlands functions under various land uses. Soil and hydrologic factors important to wetland delineation and jurisdictional determination. Mitigation of wetland impacts with emphasis on restoration and creation. Outdoor lectures at local wetlands and a two-day long field trip to observe and identify wetland soils are mandatory.
Prerequisite(s): (CSES 3114 and CSES 3124) or (ENSC 3114 and ENSC 3124) or (GEOS 3614 and GEOS 3624) or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CSES 4864 - Capstone: Crop & Soil Sciences (3 credits)
Experiential and discussion-based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan that is defended orally. Review available careers in the crop and soil sciences. Compose and critique resumes and cover letters. CSS majors only. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CSES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CSES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (ENSC)

ENSC 1015 - Foundations of Environmental Science (3 credits)
Interrelationships between human activities and the environment; emphasis on biological, chemical, and physical principles that govern the flow of energy, materials, and information among physical, ecological and human systems.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 1016 - Foundations of Environmental Science (3 credits)
National and global perspective on societal concerns about the environment and human sustenance, including agriculture. Emphasizes the relationship between human systems and natural systems; ecosystem services and land, water and atmospheric resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 3134 - Soils in the Landscape (3 credits)
A study of soils as functional landscape components, emphasizing their physical, chemical, mineralogical, and biological properties in relation to plant growth, nutrient availability, land-use management, and soil and water quality. Primarily for FOR/FIW, LAR, and other plant/earth science related majors. May not be taken by CSES or ENSC majors. Partially duplicates 3114 and 3124. Pre: one year of introductory CHEM or BIOL or GEOS.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ENSC 3604 - Fundamentals of Environmental Science (3 credits)
Interrelationships between human activities and the environment; provides national and global perspective; emphasis is on the physical, chemical, and biological principles and processes that are essential to an understanding of human-environment interactions; the role of energy in human and natural systems; environmental legislation and human behavior.
Prerequisite(s): BIOL 1105 or CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3634 - Physics of Pollution (3 credits)
Physical processes that control the fate of pollutants in our land, air, and water resources. Types and sources of pollutants, physical processes in the soil-water-atmosphere continuum controlling the dispersion and deposition of pollutants, the movement of pollutants, including radionuclides, by surface and subsurface water flow in soils, and physics of disturbed soils.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3644 - Plant Materials for Environmental Restoration (3 credits)
Overview of ecological principles related to revegetation and restoration of disturbed sites. Function and species requirements of plants in stabilizing disturbed areas including mines, rights-of-way, constructed wetlands, and for the remediation of contaminated soils.
Prerequisite(s): BIOL 1106
Corequisite(s): CSES 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: BIOL 4164

ENSC 4244 - Ecological Restoration (3 credits)
Process of assisting the recovery of degraded ecosystems by linking ecological concepts to restoration interventions. Invasive species management, revegetation methods, soil and water quality, faunal restorations. Restoration project design, planning, monitoring and implementation.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4314 - Water Quality (3 credits)
Provide comprehensive information on the physical, chemical, biological, and anthropogenic factors affecting water quality, fate and transport of contaminants in water, water quality assessment and management, and current water quality policies.
Prerequisite(s): MATH 1026 or MATH 1226 and (BIOL 1105 or BIOL 1106) and (CHEM 1035 or CHEM 1036)
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4324 - Water Quality Laboratory (1 credit)
Teach students a variety of laboratory chemical and biological techniques for water quality analysis. Complementary to ENSC/CSES 4314.
Prerequisite(s): CHEM 1046
Corequisite(s): CSES 4314, ENSC 4314
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: CSES 4324

ENSC 4344 - Ecological Restoration Field Practicum (2 credits)
Hands-on experience in planning ecological restoration projects, designing ecological restoration strategies, preparing degraded sites for restoration, managing invasive species in ecological restoration projects, implementing ecological restoration techniques, and monitoring restoration outcomes in degraded sites. Additional topics include adaptive management, stakeholder relationships, effective communication in ecological restoration projects, and challenges and barriers to restoration success.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (2 Lec, 2 Crd)

ENSC 4414 - Monitoring and Analysis of the Environment (2 credits)
Provides comprehensive hands-on-laboratory-and field-based experience and information on the principles and methods for field monitoring and sampling, as well the physical, chemical, and biological analysis of soil, surface water, groundwater, and solid wastes within the context of regulatory compliance. Optional 40-hour Hazards Materials (HAZMAT) training will be available. Senior standing required.
Prerequisite(s): (ENSC 3604 or ENSC 4314 or CSES 4314 or BIOL 4004) and (MATH 1026 or MATH 2015 and CHEM 1036 and BIOL 1105)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ENSC 4444 - Managed Ecosystems, Ecosystem Services, and Sustainability (3 credits)
Description and interactions of climate, soils, and organisms within intensively managed ecosystems used to produce food, fiber, bioenergy, fresh water, recreation, cultural, and other ecosystems services essential for human well-being. Ecological concepts applied to agricultural, grassland, and urban/turf ecosystems. Ecologically-based principles for sustainably managed ecosystems. Regional and global significance of managed ecosystems in context of sustainable food systems, and the Millennium Ecosystem Assessment. Pre-Requisite: Junior or Senior Standing required.
Prerequisite(s): CSES 3114 or CSES 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 4444

ENSC 4734 - Environmental Soil Chemistry (3 credits)
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 and CSES 3124 or ENSC 3124 or GEOS 3624 and CHEM 2514 or CHEM 2535 and CHEM 2114 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 4734

ENSC 4764 - Bioremediation (3 credits)
Overview of environmental biotechnology and the use of microbes and other organisms to remove contaminants and improve environmental quality. Topics include treatment of contaminated soils, waters, and wastewaters, as well as remediation of industrial waste streams.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4774 - Reclamation of Drastically Disturbed Lands (3 credits)
Remediation, rehabilitation, revegetation strategies for lands disturbed by mining, construction, industrialization, and mineral waste disposal. Disturbed site characterization and materials analysis procedures. Regulatory and environmental monitoring frameworks for mining sites and other disturbed lands. Prediction and remediation of water quality impacts from acid drainage.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134 or CSES 3304 or GEOG 3304 or GEOS 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ENSC 4864 - Captstone: Env Science (1 credit)
Discussion based learning that utilizes prior knowledge gained in the major to synthesize information, and prepare a written comprehensive work plan. The work plan will demonstrate the students understanding of contaminant fate and mobility in different environmental media and will be defended orally. Review and explore available careers in environmental science through seminars and working groups within environmental professionals discussing the role and responsibilities of environmental scientists in industry, consulting, regulatory agencies, and non-profits. ENSC majors only. Senior Standing.
Prerequisite(s): (CSES 3634 or ENSC 3634) and (ENSC 4414) and (CHEM 4734 or CSES 4734 or ENSC 4734) and (CSES 4854 or ENSC 4854)
Instructional Contact Hours: (3 Lab, 1 Crd)

ENSC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENSC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (HORT)

HORT 1264 - Landscape Skills Practicum (1 credit)
Relevant skills important for the success in the landscape industry. Safe equipment operation, landscape, irrigation and hardscape installation, management and estimating techniques, marketing and sales strategies, and arboriculture methods.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 2134 - Plants and Greenspaces in Urban Communities (3 credits)
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2134

HORT 2144 - Indoor Plants (3 credits)
Basic horticultural principles, identification and cultural criteria applicable to foliage and flowering plants grown indoors. Specific plant groups discussed include ferns, cacti and succulents, and carnivorous plants, among many others.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2164 - Floral Design (3 credits)
Fundamental art theory, historical and cultural influences, tools and techniques as applied to current floral art. Emphasis on applied experiential learning through designing, building and producing acceptable floral displays for home and public environments. Sustainable and ethical practices in growing and purchasing flowers. Fee $128.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 2184 - Plants, Places, and Cultures in a Global Context (3 credits)
Impact of worldwide production and trade in fruits, vegetables, and cut flowers (horticultural commodities) on societies, cultures, economies, politics, and environment. Case studies covering history, economics, social/cultural impacts of producing fruit, vegetables, tea, coffee, and other horticultural crops in producing and consuming countries. Case studies illustrate inextricable interactions and interconnectedness between horticultural crops and cultures.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2224 - Horticulture Science and Industry (2 credits)
Survey course of horticultural crops (fruits, vegetables, ornamentals) and enterprises. Includes plant science and business aspects of horticultural production and service industries, and introduces related issues and emerging technologies such as work force characteristics, organic production, and biotechnology. I.
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 2234 - Environmental Factors in Horticulture (3 credits)
Principles and practices in managing environmental factors - temperature, water, light, atmospheric gases and pollutants, and soil and minerals - that influence growth and production of horticultural plants.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 2244 - Plant Propagation (3 credits)
Principles and practices of plant propagation by sexual and asexual methods.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

HORT 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIOL 2304

HORT 2834 - Sustainable Agriculture Practicum (3 credits)
Hands-on training in sustainable agricultural production at a student-operated vegetable and fruit farm. Participation in tasks required in managing a diversified sustainable horticulture operation, including planting, pest management, irrigation, and post-harvest handling. Discussion of soil fertility, planning, efficiency, food safety and community food systems. May be repeated with different content, for a maximum of 6 credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

HORT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 3114 - Wines and Vines (3 credits)
Development of a working knowledge of world wine styles, wine appreciation, and sensory evaluation of wine. Emphasis on the influences of grape growing and winemaking practices on wine quality, style, economic value, and significance in global food culture. Pre: Must be at least 21 years of age.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 3114

HORT 3324 - Herbaceous Landscape Plants (3 credits)
Identification, growing requirements, culture, landscape use, physiology, and propagation of native and non-native herbaceous landscape plants for temperate environments. Ornamental annuals and perennials; cultivated wildflowers, plants for wetland and aquatic systems.
Prerequisite(s): HORT 2244
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3325 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3326 - Woody Landscape Plants (3 credits)
Functions, growing requirements, hardiness, problems, and methods of identification of landscape plant materials. 3325: Commonly available woody landscape plants. 3326: Native and rare woody landscape plants.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 3354 - Trees in the Built Environment (3 credits)
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment.
Prerequisite(s): (FREC 2314 or BIOL 2304 or HORT 2304) and (FREC 2324 or HORT 3325 or HORT 3326)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3354

HORT 3664 - Hardscape Materials and Installation (2 credits)
Non-plant portions of landscape construction such as rock walls, paver floors, arbors, and water gardens. The course covers the materials, construction methods, and business aspects required for hardscape construction.
Prerequisite(s): HORT 2224
Instructional Contact Hours: (6 Lab, 2 Crd)

HORT 4004 - Horticulture Seminar (1 credit)
Assessment of fundamental horticultural skills developed through academics and employment. Includes career placement preparation and problem solving through research and production project design and implementation using a team approach. Junior standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)

HORT 4205 - Public Gardens Maintenance and Management (1 credit)
4205: Principals and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/ accessions curation and database management; personnel and financial management issues unique to public gardens. Pre: Junior standing required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4206 - Public Gardens Maintenance and Management (1 credit)
4205: Principals and practices of winter annuals and spring blooming bulb production and installation; water garden cultivation and systems maintenance; fall fertilization programming; vegetative waste management; information dissemination and communication methods for public outreach including education, interpretive programs, and fundraising. 4206: Principles and practices of pruning, summer annual production; soil amendment and protection; plant collections/ accessions curation and database management; personnel and financial management issues unique to public gardens. Junior status required.
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4324 - Greenhouse Management (3 credits)
For persons who intend to manage or advise those managing commercial or institutional greenhouses. Includes greenhouse construction, environmenal controls, disease/insect identification and management, control of plant growth, root-zone management, and marketing and management principles specific to greenhouse operations. Pre: Coursework or experience in plant growth and environmental management required.
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4334 - Greenhouse and Controlled Environment Agriculture Management (3 credits)
Managing commercial or institutional greenhouses and/or controlled environment operations. Construction, environmental controls, disease/ insect identification and management, control of plant growth, root-zone management. Marketing, accounting, and management principles specific to greenhouse and controlled environment operations.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4344 - Production of Food Crops in Controlled Environment Agriculture (3 credits)
Controlled environment agriculture. Study of major hydroponic systems used in the production of horticultural food crops. Crop life cycles, nutrient requirements. Cost analysis and troubleshooting common problems that arise in controlled environment systems.
Prerequisite(s): HORT 4334
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4504 - Landscape Contracting (2 credits)
Capstone course for students entering the landscape contracting industry. Includes contracts, site plan interpretation, cost estimation and bidding, project sequencing, business marketing, irrigation design, and current issues. Emphasis on real-world skills and problem solving. Pre: Senior Standing Required.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

HORT 4545 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4546 - Small Scale and Residential Landscape Design (4 credits)
Development of graphic skills with concentration on a variety of media and techniques. Basic theory and principles on design of small scale and residential landscapes with emphasis on spatial composition, user needs, ecology, and uses of plant materials and light construction. 4545, I; 4546, II.
Prerequisite(s): HORT 3325
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

HORT 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, LAR 4554, SPIA 4554

HORT 4614 - Ornamental Plant Production and Marketing (3 credits)
In-depth production and marketing of woody and herbaceous plants in wholesale nursery and floriculture/greenhouse and related retail outlets. Includes production laboratory.
Prerequisite(s): HORT 2234 and HORT 2244 and HORT 4324 and AAEC 2434
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 4644 - Small Fruit Production (3 credits)
Propagation, production, and marketing of small fruit crops for the mid-Atlantic region. Emphasis on sustainable practices, market sectors, and health and nutritional benefits. Blueberries, strawberries, brambles and other crops.
Prerequisite(s): HORT 2234 and HORT 2244 and AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4654 - Viticulture (3 credits)
Overview of grapevine growth and development, factors affecting yield and grape quality, and regional industry. Vineyard financial considerations, site evaluation, varietal characteristics plus cultural practices of pruning, training, canopy management, fertilization and pest management.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4744 - Plant Establishment and Environmental Design (3 credits)
Plant establishment and environmental design process for sustainable landscapes emphasizing the relationship between design of human-constructed landscapes and ecosystems at larger scales. Site assessment, urban soils, site rehabilitation, plant response to disturbed environments, green infrastructure and other contemporary landscape forms. Plant selection, sourcing, and installation to achieve environmental design goals. Emphasis on hands-on, experiential learning to achieve sustainable landscapes. Pre: Senior Standing.
Prerequisite(s): HORT 2134 or FREC 2134 or CSES 3134 or ENSC 3134 or CSES 3114 or ENSC 3114 or GEOS 3614 or LAR 1254
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

HORT 4764 - Vegetable Crops (3 credits)
A comprehensive study of major and minor vegetable crops of Virginia, the U.S., and world in relation to production practices, crop development, nutritional value, and quality characteristics.
Prerequisite(s): HORT 2234
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4784 - Vegetable Seed Production (2 credits)
The study of production agriculture or reproductive biology. Seed production, handling, identification, conditioning, enhancement, packaging, storage, testing, federal standards, and biotechnology. Pre: 4764 or 2244 or equivalent experience in vegetable crops, plant propagation, or plant growth and development.
Prerequisite(s): HORT 4764 or HORT 2244
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4794 - Medicinal Plants and Herbs (3 credits)
Comprehensive study of medicinal plants/herbs history, production, processing, lore and documented scientific benefits. Traditional plant medicinal practices of Native Americans, Chinese, Indians, European and African cultures will be contrasted with use of contemporary herbal products.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

HORT 4835 - Organic Vegetable Production (2 credits)
Detailed practices in organic vegetable production. Issues in starting organic production, profitability, organic transition strategies and organic certification.
Prerequisite(s): HORT 2254 and ALS 3404
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4836 - Organic Vegetable Production (2 credits)
Detailed practices in organic vegetable production. Issues of initial and improving soil quality in organic systems, factors that affect produce quality and whole-farm weed/disease/pest management.
Prerequisite(s): HORT 4835
Instructional Contact Hours: (2 Lec, 2 Crd)

HORT 4845 - Organic Vegetable Production Laboratory (1 credit)
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures.
Corequisite(s): HORT 4835
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4846 - Organic Vegetable Production Laboratory (1 credit)
Field experiences, demonstrations, and farm tours complementing 4835 and 4836 lectures.
Corequisite(s): HORT 4836
Instructional Contact Hours: (3 Lab, 1 Crd)

HORT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HORT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (PPWS)

PPWS 2004 - Mysterious Mushrooms, Malicious Molds (3 credits)
Study of the fungi and their close relatives, with special attention to their roles in the natural world and in shaping the course of human history. Historical and practical significance of fungi as sources of medicine, pathogens of plants and animals, rotters and decayers of organic matter, makers of food and drink, manufacturers of dangerous toxins, and producers of mind-altering chemicals. A student must have a basic understanding of biology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2104 - Plants, Genes, and People (3 credits)
Explores how and why humans have manipulated plant genomes from prehistory through the current genomic era by examining the scientific, cultural, historical, and legal aspects of plant gene management in both conventional and transgenic crops.
Prerequisite(s): BIOL 1005 or BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2754 - Weeds That Shape Our World (3 credits)
How weeds shape our world, and why society will never get rid of them. Introduction to weed identification, weeds in their socio-cultural, environmental, and economic context. Consideration of the tension among their beneficial aspects, control, human attitudes, and the ethical dilemmas they post to society.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4104 - Plant Pathology (4 credits)
Introduction to plant pathology as a science and a crop protection discipline. Plant disease diagnosis, biology, and identification of plant disease-causing agents, factors leading to disease build-up, and management of plant diseases. Diseases of specific crops are studied as examples to illustrate general principles.
Prerequisite(s): (BIOL 1005 or BIOL 1105) and (BIOL 1006 or BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PPWS 4114 - Microbial Forensics and Biosecurity (3 credits)
Concepts of comparative and evolutionary genomics for pathogen characterization and identification taught through case studies of bioterrorism, involuntary and voluntary disease transmission, infectious disease epidemics, and genetically modified organisms; emphasis placed on unambiguous source attribution of a disease outbreak to a particular microbe, risk assessment, response as individual, community, and nation to a bioterrorism attack or disease outbreak, federal biosecurity regulations, and career opportunities.
Prerequisite(s): BIOL 2604 or PPWS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 4154 - Plant Problem Diagnosis (3 credits)
Plant problem diagnosis in the laboratory and field, including recognition of disease, insect and abiotic (nonliving) problems, as well as the major groups of plant pathogens of a variety of regionally important horticultural and agronomic crops. General management options for pests and pathogens.
Corequisite(s): PPWS 4104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4264 - Pesticide Usage (3 credits)
An interdisciplinary study of pesticides used in urban and agricultural environments. Topics studied will include: classification, toxicology, formulation, application techniques, safety, legal considerations, environmental impact, and research and development of new pesticides.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENT 4264

PPWS 4504 - Fundamentals of Plant Physiology (3 credits)
Fundamental principles of plant physiology (photosynthesis, respiration, transpiration, nutrition, translocation, and development) will be integrated with discussion of the relationship between abiotic environmental factors and plant physiological processes. Both agricultural and non-crop plants will be emphasized.
Prerequisite(s): (BIOL 1006 or BIOL 2304) and CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

PPWS 4604 - Biological Invasions (3 credits)
Broad overview of the causes, consequences, and epidemiology of invasive plants, animals, and microbes. Conceptual, mechanistic, societal, and political components of invasive species from Darwin to modern day, covering the invasion process from introduction to ecological or economic impact. Taxonomy, management, and risk assessment will be covered via case studies, within a policy context.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4754 - Weed Science: Principles and Practices (3 credits)
Weeds and human affairs; costs and losses; emphasis on weed biology, weed identification and weed-crop ecology; agronomic, physiological, and chemical principles underlying prevention, eradication, and control of undesired vegetation; methods of weed control available for modern agronomic, forestry, horticultural, and non-crop situations.
Prerequisite(s): BIOL 2304 and CHEM 1036
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PPWS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPWS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (SPES)

SPES 1004 - First Year Seminar (1 credit)
Exploration of topics related to the School of Plant and Environmental Sciences from a multidisciplinary perspective focusing on communication and teamwork, problem-solving, inquiry, and digital literacy.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPES 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2004 - Cannabis - Science, Industry, and Culture (3 credits)
Major crops in the genus Cannabis (hemp and marijuana). Historical development, botanical aspects, and current research. Medicinal, recreational and industrial products and their use. Legal, cultural, political and socioeconomic issues surrounding cannabis crops.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 2244 - World Crops: Food and Culture (3 credits)
How to feed the world in 2050, world crops, primary regions of production, factors that determine where they are grown, economic importance, and use in the human diet. Linkage between food and culture, recipe preparation, and their role in defining who we are, where we come from, and what we have experienced along the way. Tracing of food migration and the African, Caribbean, Asian, Latin American, and European influence on the American cuisine. The universality of food and how every single culture and religion uses food as part of the celebration of life, death, and many cultural events.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SPES 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4114 - Topics: StudyAway: Production, Culture and Social Aspects US Agriculture (3 credits)
Experiential learning, hands-on and face-to-face experience with agricultural industries involved in food production, marketing and consumption. Comparative analysis of agriculture production history, practices and constraints in different regions of the US. The course has two components. One; the in-class (onsite) discussion, analysis, and comparison of the diverse agricultural production systems between Virginia and, two; the studying “away” part (Example, California, Arizona, the Mississippi Delta). Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPES 4864 - Plant Sciences Capstone (2 credits)
Writing and discussion-based learning synthesizing prior knowledge gained in Plant Science degree program. Practice in science-based expository writing and speaking applied to undergraduate coursework, undergraduate research, or work-related experience in the Plant Sciences. Restricted to students in Plant Science degree program. Pre: Junior or Senior standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

SPES 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Crop and Soil Sciences Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
ALCE 3634	Communicating Ag and Life Sciences in Speaking	3
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
ENSC 1015	Foundations of Environmental Science	3
or ENSC 1016	Foundations of Environmental Science	
HORT/BIOL 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
PPWS 4104	Plant Pathology	4
Subtotal		23
Crop and Soil Sciences Major Requirements		
AAEC 2434	Foundations of Agribusiness	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CSES 2444	Agronomic Crops	3
CSES 3114/ GEOS 3614	Soils	3
CSES 3124/ GEOS 3624	Soils Laboratory	1
CSES 4144	Plant Breeding and Genetics	3
CSES 4214	Soil Fertility and Management	3
ENT 4254	Insect Pest Management	3
Subtotal		21
Restricted Electives		
Select an Approved Minor or a minimum of 18 credits of the following: *		18
AAEC 2104	Personal Financial Planning	
AAEC 3004	Agricultural Production and Consumption Economics	
AAEC 3314	Environmental Law	
AAEC 3504	Marketing Agricultural Products	
AAEC 3604	Agricultural Law	
ALS 3404	Ecological Agriculture: Theory and Practice	
BIOL 2804	Ecology	
CHEM 2535	Organic Chemistry	
CHEM 2536	Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
CSES 2224	Foundations of Precision Agriculture	
CSES 2244	Agriculture, Global Food Security and Health	
CSES 2434	Crop Evaluation	

CSES 2564	Turfgrass Management	
CSES 3144	Soil Description and Interpretation	
CSES 3614	Soil Physical and Hydrological Properties	
CSES 4064	Soil Microbiology	
CSES 4134	Soil Genesis and Classification	
CSES 4224	Applied Concepts in Precision Agriculture	
CSES/FREC 4334	Principles and Practice of Agroforestry	
CSES 4344	Crop Physiology and Ecology	
CSES 4544	Forage Crop Ecology	
CSES 4854	Wetland Soils and Mitigation	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC 4244	Ecological Restoration	
ENSC/CHEM 4734	Environmental Soil Chemistry	
ENSC 4774	Reclamation of Drastically Disturbed Lands	
ENT 2004	Insects and Human Society	
ENT/PPWS 4264	Pesticide Usage	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2234	Environmental Factors in Horticulture	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
HORT 4344	Production of Food Crops in Controlled Environment Agriculture	
PPWS 2754	Weeds That Shape Our World	
PPWS 4114	Microbial Forensics and Biosecurity	
PPWS 4154	Plant Problem Diagnosis	
PPWS 4604	Biological Invasions	
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 2244	World Crops: Food and Culture	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Can Select 1-3 Credit Hours from the Following Courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		18
Free Electives		
Select 13 credit hours of free electives or number to reach 120 credit hours		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1014	Precalculus with Transcendental Functions (5F)	3
or MATH 1025	Elementary Calculus	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits of Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another Pathways concept)		3
Subtotal		45
Total		
Total Credits		**120**

* **Approved Minors**

- Agribusiness Management and Entrepreneurship
- Agricultural and Applied Economics
- Animal and Poultry Sciences
- Civic Agriculture and Food Systems
- Dairy Science
- Development and International Trade
- Entomology
- Environmental Economics
- Environmental Science
- Food Science & Technology
- Global Food Security and Health
- Horticulture
- Leadership & Social Change
- Plant Health Sciences
- Turfgrass Management
- Wetland Science

Satisfactory Progress

Upon having attempted 60 credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS PLSC degree will include passing the following:

- At least 24 credits that apply to the Pathways to General Education
- CHEM 1035 General Chemistry and CHEM 1036 General Chemistry

- ALS 1234 CALS First Year Seminar or SPES 1004 First Year Seminar, CSES 3114 Soils and CSES 3124 Soils Laboratory
- 6 credits of Math

Graduation Requirements

- Total Hours Required: Minimum of 120
- GPA Requirements:
  - Overall GPA: 2.0 (each semester in order to be in good academic standing)
  - In-major GPA: 2.0 (by the time the student graduates)
    - Includes classes in: CSES, HORT, and PPWS
  - Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

SPES 1004 First Year Seminar : Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

Language Study Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1014	Precalculus with Transcendental Functions	3
SPES 1004	First Year Seminar	1
	Credits	**14**
Spring Semester		
AAEC 1005	Economics of the Food and Fiber System	3
BIOL 1106	Principles of Biology	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
ENGL 1106	First-Year Writing	3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**16**
Second Year		
Fall Semester		
ALCE 3624 or ALCE 3634	Communicating Ag and Life Sciences in Writing or Communicating Ag and Life Sciences in Speaking	3
CSES 2444	Agronomic Crops	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
ENSC 1015	Foundations of Environmental Science	3
PPWS 2104	Plants, Genes, and People	3
	Credits	**16**
Spring Semester		
AAEC 2434	Foundations of Agribusiness	3
BIOL 2304	Plant Biology	3
Pathways Concept 1 - Discourse		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Restricted Elective or Approved Minor Course		3
	Credits	**15**
Third Year		
Fall Semester		
CSES 4214	Soil Fertility and Management	3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 1 - Discourse		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**15**
Spring Semester		
CSES 4144	Plant Breeding and Genetics	3
ENT 4254	Insect Pest Management	3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
	Credits	**15**
Fourth Year		
Fall Semester		
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Spring Semester		
PPWS 4104	Plant Pathology	4
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Free Electives		4
Pathways Concept 6 - Critique and Practice in Design and the Arts		
	Credits	**14**
	Total Credits	**120**

Ecological Restoration Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
CSES 3114	Soils	3
or GEOS 3614	Soils	
CSES 3124	Soils Laboratory	1
or GEOS 3624	Soils Laboratory	
ENSC 3604	Fundamentals of Environmental Science	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
or GEOS 2104	Elements of Geology	
Select one of the following:		3
GEOG 2084	Principles of Geographic Information Systems	
GEOG/GEOS 4354	Introduction to Remote Sensing	
FREC 4114	Information Technologies for Natural Resource Management	

Subtotal		20
Major Requirements		
BIOL/HORT 2304	Plant Biology	3
BIOL 2804	Ecology	3
BIOL 3204	Plant Taxonomy	3
ENSC 3644	Plant Materials for Environmental Restoration	3
ENSC 4244	Ecological Restoration	3
ENSC 4774	Reclamation of Drastically Disturbed Lands (even years)	3
PPWS 4604	Biological Invasions	3
Subtotal		21
Restricted Electives		
Ecology		
Select nine credit hours of the following:		9
ALS 3404	Ecological Agriculture: Theory and Practice	
BIOL 4004	Freshwater Ecology	
BIOL 4114	Global Change Ecology	
BIOL 4334	Chemical Ecology	
CSES 4334	Principles and Practice of Agroforestry	
CSES 4544/ FREC 4334	Forage Crop Ecology	
ENSC 4764	Bioremediation	
FIW 4614	Fish Ecology	
FIW 4624	Marine Ecology	
FREC 2004	Forest Ecosystems	
FREC 2114	Ecology of Appalachian Forests	
Subtotal		9
Plant and Soil Sciences		
Select six credit hours of the following:		6
HORT 2244	Plant Propagation	
HORT 3324	Herbaceous Landscape Plants	
CSES 4064	Soil Microbiology	
CSES 4174	Soil Evaluation and Sampling	
CSES 3144	Soil Description and Interpretation (Soil Judging Team Preparation Course)	
CSES 4214	Soil Fertility and Management	
CSES 4854	Wetland Soils and Mitigation	
Subtotal		6
Human Dimensions		
Select three credit hours of the following:		3
AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics	
ALCE 4304	Community Education and Development	
UAP/PSCI/IS 3344	Global Environmental Issues: Interdisciplinary Perspectives	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Subtotal		3
Restricted Electives		
Select 12 credit hours of the following:		12
BIOL 2504	General Zoology	
BIOL 2704	Evolutionary Biology	
CSES 3614	Soil Physical and Hydrological Properties	
ENSC/BIOL 4164	Environmental Microbiology	
ENSC 4344	Ecological Restoration Field Practicum	
ENSC 4414	Monitoring and Analysis of the Environment	
ENSC 4734	Environmental Soil Chemistry	
FIW 2114	Principles of Fish and Wildlife Conservation	
FIW 2314	Wildlife Biology	
FIW 2324	Wildlife Field Biology	
FIW 4114	Biodiversity Conservation	
FIW 4534	Ecology and Management of Wetland Systems	
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 4084	Modeling with Geographic Information Systems	
GEOG 4314/ GEOS 4084	Spatial Analysis in Geographic Information Systems	
HORT 2134	Plants and Greenspaces in Urban Communities	
HORT 3325	Woody Landscape Plants	
HORT 3326	Woody Landscape Plants	
UAP 4374	Land Use and Environment: Planning and Policy	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		12
Free Electives		
Select remaining credits of free elective.		5
Subtotal		5
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System Principles of Economics	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025 or MATH 1225	Elementary Calculus (5F) Calculus of a Single Variable	3
MATH 1026	Elementary Calculus (5F)	3

or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another core concept)		
Subtotal		44
Total Credits		**120**

Satisfactory Progress Towards Degree

- Upon having attempted 60 semester credits (including transfer, advanced placement, advanced standing, and credit by examination) satisfactory progress towards a B.S. degree in ENSC will include passing the following:
  - At least 24 semester credits that meet the Pathways of General Education requirements,
  - BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, CSES 3114 Soils, CSES 3124 Soils Laboratory, ENSC 3604 Fundamentals of Environmental Science, SPES 1004 First Year Seminar or ALS 1234 CALS First Year Seminar, and
  - 8 credits of CHEM, with 6 credits of MATH or STAT

Graduation Requirements

- Total Hours Required: 120
- GPA requirements:
  - Overall GPA: 2.0 each semester
  - In major GPA: 2.0 by graduation
    - Includes classes in : BIOL, CHEM, CSES, ENSC, FREC, GEOS
- Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

1. SPES 1004 First Year Seminar: Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

A sequence of two foreign language courses is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1025	Elementary Calculus	3
SPES 1004 or ALS 1234	First Year Seminar or CALS First Year Seminar	1
	Credits	**14**
Spring Semester		
BIOL 1106	Principles of Biology	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
ENGL 1106	First-Year Writing	3
GEOS 1004 or GEOS 2104	Earth Science: Our Past, Present, and Future or Elements of Geology	3
MATH 1026	Elementary Calculus	3
	Credits	**16**
Second Year		
Fall Semester		
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System or Principles of Economics	3
BIOL 2804	Ecology	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
ENSC 3604	Fundamentals of Environmental Science	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**16**
Spring Semester		
BIOL 2304	Plant Biology	3
GEOG 2084 or GEOG 4354 or FREC 4114	Principles of Geographic Information Systems or Introduction to Remote Sensing or Information Technologies for Natural Resource Management	3
STAT 3615	Biological Statistics	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
	Credits	**15**
Third Year		
Fall Semester		
ENSC 3644	Plant Materials for Environmental Restoration	3
Ecology Restricted Elective		3
Plant and Soil Science Restricted Elective		3
Pathways Concept 1 - Discourse		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Spring Semester		
ENSC 4244	Ecological Restoration	3
BIOL 3204	Plant Taxonomy	3
Ecology Restrictive Elective		3
Plant and Soils Science Restricted Elective		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Fourth Year		
Fall Semester		
PPWS 4604	Biological Invasions	3
Ecology Restricted Elective		3
Human Dimension Restricted Elective		3
Restricted Electives		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
	Credits	**15**
Spring Semester		
ENSC 4774	Reclamation of Drastically Disturbed Lands	3
Restricted Electives		3
Restricted Electives		3
Restricted Electives		3

Free Electives	2
Credits	**14**
Total Credits	**120**

Environmental Horticulture Major

Program Curriculum

Code	Title	Credits
Plant Science Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
ALCE 3634	Communicating Ag and Life Sciences in Speaking	3
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
ENSC 1015	Foundations of Environmental Science	3
or ENSC 1016	Foundations of Environmental Science	
HORT/BIOL 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
PPWS 4104	Plant Pathology	4
Subtotal		23
Environmental Horticulture Major Requirements		
HORT 2224	Horticulture Science and Industry	2
HORT 2234	Environmental Factors in Horticulture	3
HORT 2244	Plant Propagation	3
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	3
HORT 3324	Herbaceous Landscape Plants	3
HORT 3325	Woody Landscape Plants	3
or HORT 3326	Woody Landscape Plants	
ENSC 3134	Soils in the Landscape	3
ENT 4254	Insect Pest Management	3
Subtotal		23
Business Requirements		
AAEC 2434	Foundations of Agribusiness	3
AAEC 3454	Small Business Management and Entrepreneurship	3
HORT 4614	Ornamental Plant Production and Marketing	3
or HORT 4344	Production of Food Crops in Controlled Environment Agriculture	
Subtotal		9
Restricted Electives		
Select 12 credits of the following:		12
AAEC 2104	Personal Financial Planning	
AAEC 3314	Environmental Law	
AAEC 3004	Agricultural Production and Consumption Economics	
AAEC 3604	Agricultural Law	
ALS 2204	Sustainable Food Systems	
ALS 3404	Ecological Agriculture: Theory and Practice	
BIOL 2004	Genetics	
CHEM 1045	General Chemistry Laboratory	
CHEM 1046	General Chemistry Laboratory	
CHEM 2535	Organic Chemistry	
CHEM 2536	Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
CSES 2224	Foundations of Precision Agriculture	
CSES 2444	Agronomic Crops	
CSES 2564	Turfgrass Management	
CSES 4344	Crop Physiology and Ecology	
CSES 4064	Soil Microbiology	
CSES 4214	Soil Fertility and Management	
ENT 2004	Insects and Human Society	
ENT 2254	Bees and Beekeeping	
ENT 2264	Bees and Beekeeping Laboratory	
ENT/PPWS 4264	Pesticide Usage	
HORT 2144	Indoor Plants	
HORT 2164	Floral Design	
HORT 2134	Plants and Greenspaces in Urban Communities	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2834	Sustainable Agriculture Practicum	
HORT 3114	Wines and Vines	
HORT 3354	Trees in the Built Environment	
HORT 3664	Hardscape Materials and Installation	
HORT 4504	Landscape Contracting	
HORT 4545	Small Scale and Residential Landscape Design	
HORT 4546	Small Scale and Residential Landscape Design	
HORT 4654	Viticulture	
HORT 4764	Vegetable Crops	
HORT 4784	Vegetable Seed Production	
HORT 4794	Medicinal Plants and Herbs	
HORT 4205	Public Gardens Maintenance and Management	
HORT 4206	Public Gardens Maintenance and Management	
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 2244	World Crops: Food and Culture	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
These courses can count as a Restrictive Elective if NOT taken for Major Requirement or Business Requirement.		
HORT 3325	Woody Landscape Plants	
or HORT 3326	Woody Landscape Plants	
HORT 4344	Production of Food Crops in Controlled Environment Agriculture	
or HORT 461	Ornamental Plant Production and Marketing	
Free Electives		
Select credits to reach 120 Total Credit Hours		8
Subtotal		20
Pathways to General Education		
Pathways Concept 1 - Discourse		

ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1014	Precalculus with Transcendental Functions (5F)	3
or MATH 1025	Elementary Calculus	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another Pathways concept)		3
Subtotal		45
Total Credits		**120**

Satisfactory Progress

Upon having attempted 60 credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS PLSC degree will include passing the following:

- At least 24 credits that apply to the Pathways to General Education
- MATH 1014 Precalculus with Transcendental Functions, CHEM 1035 General Chemistry and CHEM 1036 General Chemistry,
- HORT 2224 Horticulture Science and Industry or HORT 2234 Environmental Factors in Horticulture or HORT 2244 Plant Propagation
- 6 additional HORT courses
- 6 credits from ENSC 3134 Soils in the Landscape, ENT 4254 Insect Pest Management, PPWS 4104 Plant Pathology

Graduation Requirements

- GPA Requirements
  - Total Credit Hours Required: Minimum of 120
    - Overall GPA: 2.0 (each semester in order to be in good academic standing)
    - In-major GPA: 2.0 (by the time the student graduates)
      - Includes classes in: CSES, HORT, and PPWS
    - Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

SPES 1004 First Year Seminar : Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
ENGL 1105	First-Year Writing	3
ENSC 1015	Foundations of Environmental Science	3
HORT 2224	Horticulture Science and Industry	2
MATH 1014	Precalculus with Transcendental Functions	3
SPES 1004	First Year Seminar	1
	Credits	**15**
Spring Semester		
BIOL 1106	Principles of Biology	3
ENGL 1106	First-Year Writing	3
HORT 2244	Plant Propagation	3
HORT 2234	Environmental Factors in Horticulture	3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**15**
Second Year		
Fall Semester		
AAEC 1005	Economics of the Food and Fiber System	3
HORT 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
Pathways Concept 1 - Discourse		3
	Credits	**16**
Spring Semester		
AAEC 2434	Foundations of Agribusiness	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 2 - Critical Thinking in the Humanities		3
	3	
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**16**
Third Year		
Fall Semester		
AAEC 3454	Small Business Management and Entrepreneurship	3
ALCE 3624	Communicating Ag and Life Sciences in Writing	3
HORT 3324	Herbaceous Landscape Plants	3
Restricted Electives		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Spring Semester		
ENSC 3134	Soils in the Landscape	3

ENT 4224	Integrated Pest Management	3
HORT 3326	Woody Landscape Plants	3
Restricted Electives		3
Pathways Concept 2 - Critical Thinking in the Humanities		
	Credits	**12**
Fourth Year		
Fall Semester		
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	3
Restricted Electives		3
Restricted Electives		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
	Credits	**15**
Spring Semester		
HORT 4614 or HORT 4344	Ornamental Plant Production and Marketing or Production of Food Crops in Controlled Environment Agriculture	3
PPWS 4104	Plant Pathology	4
Restricted Electives		3
Restricted Electives		3
Free Electives		3
	Credits	**16**
	Total Credits	**120**

Environmental Science Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
CSES 3114	Soils	3
or GEOS 3614	Soils	
CSES 3124	Soils Laboratory	1
or GEOS 3624	Soils Laboratory	
ENSC 3604	Fundamentals of Environmental Science	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
or GEOS 2104	Elements of Geology	
Select one of the following:		3
GEOG 2084	Principles of Geographic Information Systems	
GEOG/GEOS 4354	Introduction to Remote Sensing	
FREC 4114	Information Technologies for Natural Resource Management	
Subtotal		20
Specific Course Requirements		
CHEM 2514	Survey of Organic Chemistry	3
or CHEM 2535	Organic Chemistry	
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
PHYS 2205	General Physics	3
or PHYS 2305	Foundations of Physics	
ENSC 3634	Physics of Pollution	3
CSES 4854	Wetland Soils and Mitigation	3
GEOS 4804	Groundwater Hydrology	3
ENSC 4734	Environmental Soil Chemistry	3
ENSC 4414	Monitoring and Analysis of the Environment	2
Subtotal		24
Major Requirements		
Select 12 credit hours of the following:		12
ALS 3404	Ecological Agriculture: Theory and Practice	
CSES 3614	Soil Physical and Hydrological Properties	
ENSC 3644	Plant Materials for Environmental Restoration	
CSES 4064	Soil Microbiology	
CSES 4134	Soil Genesis and Classification	
ENSC/BIOL 4164	Environmental Microbiology	
ENSC 4314	Water Quality	
ENSC 4764	Bioremediation	
ENSC 4774	Reclamation of Drastically Disturbed Lands	
ENSC 4244	Ecological Restoration	
FREC/WATR 3104	Principles of Watershed Hydrology	
Subtotal		12
Technical Electives		
Select 16 credit hours of the following. (Courses not listed require Program Director approval.)		16
AAEC 3314	Environmental Law	
AAEC 3324	Environment and Sustainable Development Economics	
ALS/WATR 4614	Watershed Assessment, Management, and Policy	
BIOL 2604	General Microbiology	
BIOL 2614	General Microbiology Laboratory	
BIOL 2804	Ecology	
BIOL 4004	Freshwater Ecology	
CEE 3104	Introduction to Environmental Engineering	
CEE 4134	Environmental Sustainability - A Systems Approach	
CEE 4174	Solid and Hazardous Waste Management	
CHEM 4514	Green Chemistry	
CHEM 4615	Physical Chemistry for the Life Sciences	
CSES/GEOG/GEOS 3304	Geomorphology	
CSES 3144	Soil Description and Interpretation	
CSES 4214	Soil Fertility and Management	
ENGR 3124	Introduction to Green Engineering	
ENGR 4134	Environmental Life Cycle Assessment	
FIW 4534	Ecology and Management of Wetland Systems	
FIW 4624	Marine Ecology	
FREC/WATR 3754	Watersheds and Water Quality Monitoring	
FREC 4334	Principles and Practice of Agroforestry	
FREC 4354	Forest Soil and Watershed Management	
FREC 4374	Forested Wetlands	
FREC 4784	Wetland Hydrology and Biogeochemistry	

GEOG 3314	Cartography	
GEOG/GEOS 4084	Modeling with Geographic Information Systems	
GEOG 4314	Spatial Analysis in Geographic Information Systems	
GEOG/GEOS 4354	Introduction to Remote Sensing	
GEOS 3034	Oceanography	
GEOS 3404	Elements of Structural Geology	
GEOS 4634	Environmental Geochemistry	
PHS 3014	Introduction to Environmental Health	
PHS 4054	Concepts in One Health [1]	
PPWS 4114	Microbial Forensics and Biosecurity	
UAP/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4264	Environmental Ethics and Policy	
UAP 4344	Law of Critical Environmental Areas	
UAP 4374	Land Use and Environment: Planning and Policy	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		16
Free Electives		
Select remaining credit hours of free electives to meet minimum degree requirements.		4
Subtotal		4
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
or ENGL 2844	Introduction to Professional and Technical Writing	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	3
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [2]		
Subtotal		44
Total Credits		**120**

Satisfactory Progress

- Upon having attempted 60 semester credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS ENSC will include passing the following courses:
  - At least 24 credits that apply to the Pathways of General Education,
  - BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, CSES 3114 Soils , CSES 3124 Soils Laboratory, ENSC 3604 Fundamentals of Environmental Science, SPES 1004 First Year Seminaror ALS 1234 CALS First Year Seminar and
  - 12 credits of CHEM, 9 credits of MATH and/or STAT.

Graduation Requirements

- Total Hours Required: Minimum of 120
- GPA Requirements:
  - Overall GPA: 2.0 (each semester in order to be in good academic standing)
  - C- or better grade in CHEM 1035, CHEM 1036, CHEM 2514 or CHEM 2535, and CHEM 2114
- In-major GPA: 2.0 (by the time the student graduates)
  - Includes classes in BIOL, CHEM, CSES, ENSC, FREC, GEOS, PHYS
- Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

SPES 1004 First Year Seminar: Any University approved First Year Experience (FYE) Course.

Foreign Language Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3

MATH 1025	Elementary Calculus	3
SPES 1004 or ALS 1234	First Year Seminar or CALS First Year Seminar	1
	Credits	**14**
Spring Semester		
BIOL 1106	Principles of Biology	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
ENGL 1106	First-Year Writing	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
MATH 1026	Elementary Calculus	3
	Credits	**16**
Second Year		
Fall Semester		
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System or Principles of Economics	3
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
ENSC 3604	Fundamentals of Environmental Science	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**17**
Spring Semester		
AAEC 1006 or ECON 2006	Economics of the Food and Fiber System or Principles of Economics	3
CHEM 2514 or CHEM 2536	Survey of Organic Chemistry or Organic Chemistry	3
PHYS 2205	General Physics	3
STAT 3615	Biological Statistics	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Third Year		
Fall Semester		
CSES 4854	Wetland Soils and Mitigation	3
ENGL 3764	Technical Writing (Junior Standing Required)	3
GEOG 2084 or GEOS 4354 or FREC 4114	Principles of Geographic Information Systems or Introduction to Remote Sensing or Information Technologies for Natural Resource Management	3
Major Specific Course		3
Major Specific Course		3
	Credits	**15**
Spring Semester		
Pathways Concept 2 - Critical Thinking in the Humanities		3
Major Specific Course		3
Major Specific Course		3
Technical Electives		3
Technical Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
ENSC 3634	Physics of Pollution	3
GEOS 4804	Groundwater Hydrology	3
Technical Electives		3
Technical Electives		3
Technical Electives		3
	Credits	**15**
Spring Semester		
ENSC 4414	Monitoring and Analysis of the Environment	2
ENSC 4734	Environmental Soil Chemistry	3
Technical Electives		3
Free Elective		3
Free Elective		2
	Credits	**13**
	Total Credits	**120**

Integrated Agriculture Technologies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
ALCE 3634	Communicating Ag and Life Sciences in Speaking	3
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
ENSC 1015	Foundations of Environmental Science	3
or ENSC 1016	Foundations of Environmental Science	
HORT/BIOL 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
PPWS 4104	Plant Pathology	4
Subtotal		23
Major Requirements		
CSES 2444	Agronomic Crops	3
or HORT 2234	Environmental Factors in Horticulture	
or CSES 2564	Turfgrass Management	
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
CSES 2224	Foundations of Precision Agriculture	3
CSES 4224	Applied Concepts in Precision Agriculture	3
CSES 4234	Agro Data Integration	3
CSES 4524	Drone Applications in Ag Systems	3
CSES 4534	Internet of Things (IoT) for Smart Farming	3
GEOG 2084	Principles of Geographic Information Systems	3
Subtotal		25
Restricted Electives		
Select an Approved Minor or a minimum of 18 credits of the following: [1]		18
AAEC 2104	Personal Financial Planning	
AAEC 2434	Foundations of Agribusiness	
AAEC 3004	Agricultural Production and Consumption Economics	
AAEC 3314	Environmental Law	
AAEC 3504	Marketing Agricultural Products	
AAEC 3604	Agricultural Law	
ALS 3404	Ecological Agriculture: Theory and Practice	
BIOL 2804	Ecology	
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	

CSES 2244	Agriculture, Global Food Security and Health	
CSES 2434	Crop Evaluation	
CSES 3144	Soil Description and Interpretation	
CSES 3614	Soil Physical and Hydrological Properties	
CSES 4134	Soil Genesis and Classification	
CSES 4144	Plant Breeding and Genetics	
CSES 4214	Soil Fertility and Management	
CSES 4344	Crop Physiology and Ecology	
CSES 4544	Forage Crop Ecology	
CSES 4854	Wetland Soils and Mitigation	
ENSC 3644	Plant Materials for Environmental Restoration	
ENSC 4734	Environmental Soil Chemistry	
ENSC 4764	Bioremediation	
ENSC 4774	Reclamation of Drastically Disturbed Lands	
ENT 4254	Insect Pest Management	
ENT/PPWS 4264	Pesticide Usage	
GEOG 4354	Introduction to Remote Sensing	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2234	Environmental Factors in Horticulture	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
PHYS 2205	General Physics	
or PHYS 230	Foundations of Physics	
PHYS 2206	General Physics	
PPWS 2754	Weeds That Shape Our World	
PPWS 4114	Microbial Forensics and Biosecurity	
PPWS 4154	Plant Problem Diagnosis	
PPWS 4604	Biological Invasions	
SPES 2004	Cannabis - Science, Industry, and Culture	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		18
Free Electives		
Select remaining credit hours of free electives to fulfill 120 credit hour minimum.		7
Subtotal		7
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select 3 credits in Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
CS 1014	Introduction to Computational Thinking	3
MATH 1025	Elementary Calculus	3
or MATH 1225	Calculus of a Single Variable	
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits of Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another Pathways concept)		3
Subtotal		47
Total Credits		**120**

[1] **Approved Minors**

- Agribusiness Management and Entrepreneurship
- Agricultural and Applied Economics
- Animal and Poultry Sciences
- Civic Agriculture and Food Systems
- Computer Science
- Crop and Soil Environmental Science
- Dairy Science
- Entomology
- Environmental Economics
- Environmental Science
- Food Science & Technology
- Global Food Security and Health
- Horticulture
- International Trade & Development
- Leadership & Social Change
- Plant Health Sciences
- Turfgrass Management
- Wetland Science

Satisfactory Progress

- Upon having attempted 60 credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS PLSC degree will include passing the following:
  - At least 24 credits that apply to the Pathways to General Education

- CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, CSES 3124 Soils Laboratory, and ALS 1234 CALS First Year Seminar or SPES 1004 First Year Seminar
  - 6 credits of Math
- Includes classes in CSES, HORT, and PPWS

Graduation Requirements

- Total Credit Hours Required: Minimum of 120
- GPA Requirements
  - Overall GPA: 2.0 (each semester in order to be in good academic standing)
  - In-major GPA: 2.0 (by the time the student graduates)
    - Includes classes in: CSES, ENSC, HORT, and PPWS
- Prerequisites: Some courses listed may have pre-/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

1. SPES 1004 First Year Seminar : Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1025	Elementary Calculus	3
SPES 1004	First Year Seminar	1
	Credits	**14**
Spring Semester		
BIOL 1106	Principles of Biology	3
CHEM 1046	General Chemistry Laboratory	1
CHEM 1036	General Chemistry	3
CS 1014	Introduction to Computational Thinking	3
ENGL 1106	First-Year Writing	3
Restricted Elective or Approved Minor Course		3
	Credits	**16**
Second Year		
Fall Semester		
CSES 2224	Foundations of Precision Agriculture	3
ENSC 1015	Foundations of Environmental Science	3
HORT 2224 or CSES 2444 or CSES 2564	Horticulture Science and Industry or Agronomic Crops or Turfgrass Management	2
PPWS 2104	Plants, Genes, and People	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**14**
Spring Semester		
ALCE 3624 or ALCE 3634	Communicating Ag and Life Sciences in Writing or Communicating Ag and Life Sciences in Speaking	3
GEOG 2084	Principles of Geographic Information Systems	3
HORT 2304	Plant Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Third Year		
Fall Semester		
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System or Principles of Economics	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
CSES 4234	Agro Data Integration	3
CSES 4224	Applied Concepts in Precision Agriculture	3
Pathways Concept 1 - Discourse		3
	Credits	**16**
Spring Semester		
PPWS 4104	Plant Pathology	4
SPES 2244	World Crops: Food and Culture	3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**16**
Fourth Year		
Fall Semester		
CSES 4524	Drone Applications in Ag Systems	3
CSES 4534	Internet of Things (IoT) for Smart Farming	3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Spring Semester		
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Restricted Elective or Approved Minor Course		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Landscape Design and Turfgrass Science Major

Program Curriculum

Code	Title	Credits
Plant Science Degree Core Requirements		
ALS 1234 or SPES 1004	CALS First Year Seminar First Year Seminar	1
ALCE 3634 or ALCE 3624	Communicating Ag and Life Sciences in Speaking Communicating Ag and Life Sciences in Writing	3
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
ENSC 1015 or ENSC 1016	Foundations of Environmental Science Foundations of Environmental Science	3
HORT/BIOL 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
PPWS 4104	Plant Pathology	4
Subtotal		23

Landscape Design and Turfgrass Science Major Requirements		
AAEC 2434	Foundations of Agribusiness	3
AAEC 3454	Small Business Management and Entrepreneurship	3
CSES 2564	Turfgrass Management	3
CSES 3114/ GEOS 3614	Soils	3
CSES 3124/ GEOS 3624	Soils Laboratory	1
ENT 4254	Insect Pest Management	3
HORT 2224	Horticulture Science and Industry	2
HORT 2234	Environmental Factors in Horticulture	3
HORT 2244	Plant Propagation	3
Subtotal		24
Please choose between Track 1: Landscape Design or Track 2: Turfgrass Science		**18-19**
Track 1: Landscape Design Requirements		
Complete All 5 Course Listed Below for 16 Credit Hours		
HORT 4504	Landscape Contracting	
HORT 4545	Small Scale and Residential Landscape Design	
HORT 4546	Small Scale and Residential Landscape Design	
HORT 3325	Woody Landscape Plants	
or HORT 332	Woody Landscape Plants	
HORT 3324	Herbaceous Landscape Plants	
Track 1: Landscape Design Concentration Restricted Electives		
Select 3 credits from the following courses:		
ALS 3404	Ecological Agriculture: Theory and Practice	
ENT 2004	Insects and Human Society	
ENT/PPWS 4264	Pesticide Usage	
CSES 2224	Foundations of Precision Agriculture	
ENSC 3644	Plant Materials for Environmental Restoration	
HORT 2144	Indoor Plants	
HORT 2164	Floral Design	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT/FREC 3354	Trees in the Built Environment	
HORT 4205	Public Gardens Maintenance and Management	
HORT 4206	Public Gardens Maintenance and Management	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
HORT 4614	Ornamental Plant Production and Marketing	
SPES 2244	World Crops: Food and Culture	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Track 2: Turfgrass Science Requirements		
Complete All 3 Course Liisted Below for 9 Credit Hours		
CSES 3564	Golf and Sports Turf Management	
CSES 4214	Soil Fertility and Management	
CSES 4864	Capstone: Crop & Soil Sciences	
Track 2: Turfgrass Science Restricted Electives		
Select 9 credit hours from the following courses:		
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations	
ENT 2004	Insects and Human Society	
ENT/PPWS 4264	Pesticide Usage	
CSES 2224	Foundations of Precision Agriculture	
HORT 2144	Indoor Plants	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 4205	Public Gardens Maintenance and Management	
HORT 4206	Public Gardens Maintenance and Management	
HORT 4504	Landscape Contracting	
HORT 4545	Small Scale and Residential Landscape Design	
HORT 4546	Small Scale and Residential Landscape Design	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
SPES 4994	Undergraduate Research (1-3)	
Subtotal		18-19
Free Electives		
Select credits to reach 120 Total Credit Hours		10
Subtotal		10
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1014	Precalculus with Transcendental Functions (5F)	3
or MATH 1025	Elementary Calculus	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		

Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another Pathways concept)	3
Subtotal	45
Total Credits	**120-121**

Satisfactory Progress

Upon having attempted 60 credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS PLSC degree will include passing the following courses:

- At least 24 credits that apply to the Pathways of General Education
- MATH 1014 Precalculus with Transcendental Functions, CHEM 1035 General Chemistry and CHEM 1036 General Chemistry,
- HORT 2224 Horticulture Science and Industry or HORT 2234 Environmental Factors in Horticulture or HORT 2244 Plant Propagation,
- 6 credits from ENSC 3134 Soils in the Landscape, ENT 4254 Insect Pest Management, PPWS 4104 Plant Pathology
- 6 additional HORT classes

Graduation Requirements

- Total Credit Hours Required: Minimum of 120
- GPA Requirements
  - Overall GPA: 2.0 (each semester in order to be in good academic standing)
  - In-major GPA: 2.0 (by the time the student graduates)
    - Includes classes in: CSES, ENSC, HORT, and PPWS
- Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

1. SPES 1004 First Year Seminar : Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
ENGL 1105	First-Year Writing	3
ENSC 1015	Foundations of Environmental Science	3
HORT 2224	Horticulture Science and Industry	2
MATH 1014	Precalculus with Transcendental Functions	3
SPES 1004	First Year Seminar	1
	Credits	**15**
Spring Semester		
BIOL 1106	Principles of Biology	3
ENGL 1106	First-Year Writing	3
HORT 2244	Plant Propagation	3
HORT 2234	Environmental Factors in Horticulture	3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**15**
Second Year		
Fall Semester		
AAEC 1005	Economics of the Food and Fiber System	3
CHEM 1035	General Chemistry	3
CSES 2564	Turfgrass Management	3
HORT 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
	Credits	**15**
Spring Semester		
AAEC 2434	Foundations of Agribusiness	3
CHEM 1036	General Chemistry	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Third Year		
Fall Semester		
AAEC 3454	Small Business Management and Entrepreneurship	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
Concentration Requirement or Restrictive Elective		3
Concentration Requirement or Restrictive Elective		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**16**
Spring Semester		
ALCE 3624 or ALCE 3634	Communicating Ag and Life Sciences in Writing or Communicating Ag and Life Sciences in Speaking	3
ENT 4254	Insect Pest Management	3
PPWS 4104	Plant Pathology	4
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
	Credits	**16**
Fourth Year		
Fall Semester		
CSES 4214	Soil Fertility and Management	3
Concentration Requirement or Restrictive Elective		3
Concentration Requirement or Restrictive Elective		3
Concentration Requirement or Restrictive Elective		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Spring Semester		
Concentration Requirement or Restrictive Elective		3
Concentration Requirement or Restrictive Elective		3
Concentration Requirement or Restrictive Elective		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
Free Electives		1
	Credits	**13**
	Total Credits	**120**

Plant Science Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ALS 1234	CALS First Year Seminar	1
or SPES 1004	First Year Seminar	
ALCE 3634	Communicating Ag and Life Sciences in Speaking	3
or ALCE 3624	Communicating Ag and Life Sciences in Writing	
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
ENSC 1015	Foundations of Environmental Science	3
or ENSC 1016	Foundations of Environmental Science	
HORT 2304	Plant Biology	3
PPWS 2104	Plants, Genes, and People	3
PPWS 4104	Plant Pathology	4
Subtotal		23
Major Requirements		
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3-4
or BCHM 4115	General Biochemistry	
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2536	Organic Chemistry	3
CHEM 2546	Organic Chemistry Laboratory	1
CSES 2444	Agronomic Crops	2-3
or HORT 2224	Horticulture Science and Industry	
CSES 4144	Plant Breeding and Genetics	3
CSES 4344	Crop Physiology and Ecology	3
Subtotal		21-23
Restricted Electives		
Select 15 credits from the following courses:		15
ALS 3404	Ecological Agriculture: Theory and Practice	
BCHM 2114	Biochemical Calculations	
BCHM/APSC 4054	Genomics	
BCHM 4116	General Biochemistry	
BIOL 2004	Genetics	
BIOL 2134	Cell Function and Differentiation	
BIOL 4134	Evolutionary Genetics	
BIOL 4334	Chemical Ecology	
CSES 2224	Foundations of Precision Agriculture	
Select one of the following:		
CSES 3114/ GEOS 3614	Soils	
And		
CSES 3124/ GEOS 3624	Soils Laboratory	
Or		
ENSC 3134	Soils in the Landscape	
CSES 2244	Agriculture, Global Food Security and Health	
CSES 4064	Soil Microbiology	
CSES 4224	Applied Concepts in Precision Agriculture	
CSES/FREC 4334	Principles and Practice of Agroforestry	
CSES 4544	Forage Crop Ecology	
HORT 2184	Plants, Places, and Cultures in a Global Context	
HORT 2234	Environmental Factors in Horticulture	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
HORT 4794	Medicinal Plants and Herbs	
PPWS 2004	Mysterious Mushrooms, Malicious Molds	
PPWS 2754	Weeds That Shape Our World	
PPWS 4114	Microbial Forensics and Biosecurity	
PPWS 4154	Plant Problem Diagnosis	
PPWS 4604	Biological Invasions	
SPES 2244	World Crops: Food and Culture	
SPES 4114	Topics: StudyAway: Production, Culture and Social Aspects US Agriculture	
Up to 3 credit hours can be selected from the following courses:		
SPES 3954	Study Abroad (1-3)	
SPES 4964	Field Study (1-3)	
SPES 4974	Independent Study (1-3)	
PPWS 4994	Undergraduate Research (1-3)	
Subtotal		15
Free Electives		
Select free electives to fulfilfill 120 total credit hours required.		16
Subtotal		16
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	3
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		

Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double-counted with another Pathways concept)	3
Subtotal	45
Total Credits	**120-122**

Satisfactory Progress

Upon having attempted 60 credits (including transfer, advanced placement, advanced standing and credit by examination), "satisfactory progress" toward a BS PLSC degree will include passing the following:

- At least 24 credits that apply to the Pathways to General Education
- CHEM 1035 General Chemistry and CHEM 1036 General Chemistry
- ALS 1234 CALS First Year Seminar or SPES 1004 First Year Seminar
- 6 credits of Math

Graduation Requirements

- Total Credit Hours Required: Minimum of 120
- GPA Requirements:
  - In-major GPA: 2.0 (by the time the student graduates)
    - Includes classes in: CSES, HORT, and PPWS
  - Overall GPA: 2.0 (each semester in order to be in good academic standing)
- Prerequisites: Some courses listed may have pre/co-requisites; please consult the University Catalog or check with your advisor.

Acceptable Substitutions

SPES 1004 First Year Seminar : Any University approved First Year Experience (FYE) Course

Foreign Language Requirement

A sequence of two foreign language courses (Classical or ASL) is required unless two years of the same high school foreign language or 6 transfer credits of the same foreign language are completed. These credits **do not** count toward graduation requirements.

First Year		
Fall Semester		**Credits**
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1025	Elementary Calculus	3
SPES 1004	First Year Seminar	1
	Credits	**14**
Spring Semester		
BIOL 1106	Principles of Biology	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
ENGL 1106	First-Year Writing	3
MATH 1026	Elementary Calculus	3
	Credits	**13**
Second Year		
Fall Semester		
CHEM 2535	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
ENSC 1015	Foundations of Environmental Science	3
HORT 2224 or CSES 2444	Horticulture Science and Industry or Agronomic Crops	2
PPWS 2104	Plants, Genes, and People	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Spring Semester		
ALCE 3624 or ALCE 3634	Communicating Ag and Life Sciences in Writing or Communicating Ag and Life Sciences in Speaking	3
CHEM 2536	Organic Chemistry	3
CHEM 2546	Organic Chemistry Laboratory	1
HORT 2304	Plant Biology	3
STAT 3615	Biological Statistics	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**16**
Third Year		
Fall Semester		
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System or Principles of Economics	3
BCHM 3114 or BCHM 4115	Biochemistry for Biotechnology and the Life Sciences or General Biochemistry	3
Restricted Electives		3
Restricted Electives		3
Pathways Concept 1 - Discourse		3
	Credits	**15**
Spring Semester		
CSES 4144	Plant Breeding and Genetics	3
PPWS 4104	Plant Pathology	4
Restricted Electives		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
	Credits	**16**
Fourth Year		
Fall Semester		
Restricted Electives		3
Restricted Electives		3
Restricted Electives		3
Restricted Electives		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Spring Semester		
CSES 4344	Crop Physiology and Ecology	3
Restricted Electives		3
Restricted Electives		3
Free Electives		4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
	Credits	**16**
	Total Credits	**120**

Architecture, Arts, and Design

Our Website (http://www.aad.vt.edu)

Overview

The College of Architecture, Arts, and Design is comprised of four schools. The School of Architecture includes accredited undergraduate and graduate programs in architecture. The School of Design includes accredited undergraduate and graduate programs in landscape architecture, interior design, and an undergraduate program in industrial design. The School of Visual Arts offers undergraduate programs in art history, creative technologies, studio art, and graphic design as well as a Master of Fine Arts in creative technologies and a Master's in Material Culture and Public Humanities, jointly with the College of Liberal Arts and Human Sciences. The School of Performing Arts offers undergraduate programs in music, theatre, and cinema as well as a Master's in Theatre. The School of Performing Arts also offers a graduate certificate in arts leadership. These programs share a common purpose—to understand and shape the spaces and places where we live, work and play.

Research and outreach programs supplement instructional efforts and are carried out through college centers and laboratories. Specialized research and outreach centers offer students and faculty members opportunities for concentrated investigations in such areas as history and theory of art and architecture, housing, community design, high performance learning environments, music education, community health, women in architecture, environmental design, design research, and visual design.

The college offers a range of advanced digital technologies including an array of rapid prototyping devices and a wide range of computing and graphic equipment in support of the instructional and research programs of the college. The Environmental Systems Laboratory (ESL) and the Research and Demonstration Facility (RDF) are available to faculty members and students for the conduct of research, in-depth investigations of environmental systems, prototype development, and industrial, graphic, and product design. To support these endeavors, the college has the Virtual Environments Laboratory (VE Lab), Center for Advanced Visual Media, and the Visual Design Studio for Education, Research, Exhibition, and Outreach.

The Art and Architecture Library, a branch of the University Libraries, is located in Cowgill Hall and houses more than 60,000 volumes, 200 periodicals, and 65,000 architectural slides. The college also provides media facilities - VTR systems, photographic darkroom, printmaking, ceramics, and cinematographic space and equipment, 3-D printing, and plastics, wood and metal shops.

The college's Washington-Alexandria Architecture Center and Northern Virginia Center in Old Town Alexandria provide opportunities for architecture, landscape architecture, public administration, and urban and regional planning students to spend one or more semesters in the Washington, DC metropolitan area examining the range of design and planning problems found in large urban centers. In addition to classes, studios, and curricula at the undergraduate and graduate levels, the centers offer research and continuing education opportunities for students, faculty, and alumni, and facilitates participation in the rich educational and cultural opportunities of the greater Washington area.

The Europe Studio, based at the university's Steger Center for European Studies and Architecture in Riva San Vitale, Switzerland, provides undergraduate and graduate study opportunities for students college-wide. Studios, seminars, and organized travel are offered. The college also sponsors an array of additional study abroad opportunities, including study-travel programs elsewhere in the world.

Students who wish to combine degree options within the college or with related disciplines within the university should contact the major school or department regarding special undergraduate and graduate program requirements.

- Architecture Major (p. 593)
- Art Major with Art History Option (p. 639)
- Cinema Major (p. 652)
- Creative Technologies Major (p. 641)
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Dean: Lu Liu
Associate Dean for Academic Affairs: Kathryn Clarke Albright
Interim Associate Dean for Research and Creative Scholarship: Michael Borowski
Associate Dean for Graduate Studies: Paul Emmons
Associate Dean for Outreach and Engagement: Ariana Wyatt

Undergraduate Course Descriptions (AAD)

AAD 1004 - Exploring Architecture, Arts, and Design (2 credits)
First-Year Experience course for Explore AAD majors. Overview of the college and its degrees, majors and minors, and career opportunities available to CAUS graduates. Presents college and university resources and services that support student success. Introduces students to the basic principles of the research process by focusing on inquiry, problem-solving, and integration of ideas and experiences within the fields in the College of Architecture, Arts, and Design.
Instructional Contact Hours: (2 Lec, 2 Crd)

AAD 1204 - Thinking Globally (1 credit)
Seminar for first-year students enrolled in Rhizome Living-Learning Community. Introduction to systems thinking. Simple and complex systems. Systems approach to sustainable development. International perspectives on, and goals for, sustainable development. Considers United Nations Sustainable Development Goals (SDGS), SDGs History, global progress towards SDGs and Criticisms of SDGs and United Nations. Exploration of Rhizome LLC yearly theme.
Instructional Contact Hours: (1 Lec, 1 Crd)

AAD 1214 - Acting Locally (2 credits)
Course for first-year students enrolled in Rhizome Living-Learning Community. Project-based learning through student-client collaborations. Applies systems thinking concepts and United Nations Sustainable Development Goals. Introduces design thinking as a model for problem solving, including problem definition and iteration. Student presentations, proposal development, exhibition, client feedback and peer critiques.
Prerequisite(s): AAD 1204
Instructional Contact Hours: (2 Lec, 2 Crd)

AAD 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

AAD 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 3984L - Special Study (1-19 credits)
Pathway Concept Area(s): 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

AAD 3984M - Special Study (3 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: (3 Lec, 3 Crd)

AAD 4234 - Capstone Collaborations: Cross-Disciplinary Teams (3 credits)
Collaborative cross-disciplinary research teams support discipline-specific capstones. Analyzes the interactive relationships between place, space, identity, and community in the United States and beyond. Engages in iterative research processes through reflective teamwork addressing complex problems in senior capstone projects. Synthesizes multiple, complex sources and creates coherent arguments including ethical analyses.
Prerequisite(s): ENGE 2094 and PHIL 3334
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

AAD 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

AAD 5954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

School of Architecture

Our Website (https://arch.vt.edu/)

Overview

Architecture enriches our lives by offering us environments that are sensibly compelling, thought provoking, and capable of lifting our spirits. In addition to being beautiful, architecture is, by ancient definition, functional and durable. Like art, architecture is permeated by dualities. It is stable and transitory, measurable and immeasurable, and capable of both being touched and touching us. Like science, architecture involves systematic study. Its methods are iterative, experimental, and rely on intense observation. By intertwining the poetic and practical, architecture is uniquely poised to address the challenges of contemporary life and reflect the culture of the 21st century.

The professional curriculum in architecture requires five years of study for the first professional degree, the Bachelor of Architecture (B. Arch.).

The first professional degree programs at Virginia Tech, the five-year Bachelor of Architecture degree (B. Arch.), the Master of Architecture II (M.Arch.2), and the Master of Architecture III (M.Arch.3) degrees, are fully accredited for the current maximum six-year term of accreditation by the National Architectural Accrediting Board.

All students in the School of Architecture begin their studies in a common first year foundation program. Following the foundation program, students pursue professional studies in the 2-3 and 4-5 programs.

Foundation Design Program - First Year

Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgment and critical understanding. Studies are undertaken in two and three dimensions across multiple scales.

Professional Program - Second, Third, Fourth, and Fifth Years

The Professional Program employs design theory and processes to study the design of buildings. Students conduct an interactive investigation of architectural space, environmental forces, and building technology. Foundations of discipline-specific knowledge are progressively introduced, discussed, and examined as they contribute to the complex totality of a work of architecture. Students explore natural and cultural forces as they relate to architecture through means of representation specific to the discipline. With architecture at the core, the program examines interdisciplinary sources such as art, science, and philosophy for the purpose of establishing the content the discipline shares with other forms of knowledge.

Concepts in the Professional Program are communicated through both physical drawings and models, as well as through virtual tools and digital production. All coursework seeks to develop the ability to conduct a professional written and verbal discourse. Further emphasis is placed on intellectual discipline, constructive dialogue, assertion of interest, and a self-motivated search for critical issues.

The **second year** is characterized by an increase in the complexity of design exercises to foster a better understanding of the interplay between situation, time and desired spatial definition. Architectural constructs of smaller scales build on knowledge of basic design principles studied in the first year. The laboratory discourse focuses on principal elements of architecture and their compositional and material role in space.

Architecture as the art of building is conveyed through the detailed study of exemplary built works.

The **third year** provides for study of fundamental design principles, technical concepts and their applications, including measures of quality in architecture. The instructional content of this year articulates and communicates to students the unique nature of architecture through the study of interrelationships of material, construction systems, site, and building programs. The Architecture III design laboratory guides the student's growing experience with practical design problems and provides order to the gradual exploration and learning of the nature and means of achieving architecture. Associated with Architecture Ill are lectures, presentations, and workshops intended to challenge students toward sensible integration of necessary systems and legal responsibilities in the design and construction of buildings.

The **fourth year** builds on the increased comprehension of building systems acquired during the third year. On-campus or off-campus, the aim of the various program options is to promote an in-depth understanding of the relationship between architectural idea and physical building form. On-campus students are offered studio courses with various focus topics. Off-campus options include several VT and non-VT Study Abroad Programs, the Extern Program, the Washington-Alexandria Architecture Campus, or the Chicago Studio.

Off-campus programs directed by the Architecture program include:

- *The Europe Study Abroad Travel Program studies* seminal European historic and contemporary architectural works and urban spaces, which are visited and documented with analytical drawings, sketches, and photographs, supplemented by on-site lectures by architects and professionals. Documented research before and after the program leads students to greater depth of understanding of the issues surrounding the architecture.
- *The Steger Center Residency Program:* Each semester, 16 architecture students take part in this program at Virginia Tech's European Steger Center for International Scholarship in Riva San Vitale, Switzerland. An 18th century villa and its gardens on the southern tip of Lake Lugano provide residence and dining facilities for Architecture students, as well as 30 Virginia Tech students from other academic disciplines. Studio work, courses, research, and travel are directed to advance first-hand knowledge of the architecture, geography, and culture of Europe.
- *Boston, Chicago, and other City Lab* options are alternatives to the traditional fourth year Blacksburg-based semester. These off-campus programs integrate design education with interactions between the profession within an urban context.
- *Professional Extern Program* allows students to spend one semester in an approved professional setting and receive up to 12 hours of academic credit. This program provides a valuable link between the academic environment and architectural practices, discipline-related government agencies, and other design offices throughout the world.
- *The Washington-Alexandria Architecture Campus* affords students from the School of Architecture and from related College disciplines the opportunity to study with students and faculty from a national and international consortium of schools in the historic urban context of Old Town Alexandria. The WAAC complex offers studio space, classrooms, exhibition and review spaces, shops, and computer labs for the students and faculty of the consortium. The University also offers a limited number of apartments for students studying in Alexandria.

In the **fifth year**, students conduct a yearlong advanced study with individual faculty advisors. The in-depth engagement with research, theory, and design is intended to broaden a student's expertise in a particular area within the field of architecture. Fifth-year students are expected to formulate and accomplish advanced high-level work in the form of a terminal project. Working with their advisors, students develop and discuss their research and design progress, and have periodic formal peer reviews throughout the year. Students are required to leave the project documentation of their 5th-year work with the school upon graduation.

The first professional degree programs (B.Arch., M.Arch.2 & M.Arch.3) in architecture are accredited by the National Architectural Accrediting Board (NAAB).

- In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes three types of degrees: the Bachelor of Architecture, the Master of Architecture, and the Doctor of Architecture. A program may be granted a 6-year, 3-year, or 2-year term of accreditation, depending on the extent of its conformance with established educational standards.
- Doctor of Architecture and Master of Architecture degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree that, when earned sequentially, constitute an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree.
- Next accreditation visit for all Architecture programs: 2027

A four-year, pre-professional degree is not offered at Virginia Tech.

Program Requirements

Graduation Requirements

Upon successful completion of program requirements of the foundation level of study and the professional levels of study in architecture and with completion of 160 credit hours of study, a first professional degree of Bachelor of Architecture is awarded.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in Architecture.

Satisfactory progress requirements toward the degree can be found on the University Catalog by visiting https://catalog.vt.edu/.

- Architecture Major (p. 593)

Director - School of Architecture: J. Bassett
Chair - Foundation Program: C. Pritchett
Chair - Undergraduate Architecture Program: P. Doan
Chair - Graduate Program: D. Dugas
Professors: K. Albright, M. Breitschmid, H. de Hahn, R. Dunay, P. Emmons, M. Ermann, J. Jones, S. Piedmont-Palladino, M. Setareh, M. Stamm, and J. Wheeler

Associate Professors: J. Bassett, E. Becker, J. Bedford, H. Bryon, P. Doan, D. Dugas, W. Galloway, S. Gartner, R. Gibbson, P. Kelsch, S. Martin, M. McGrath, H. Pittman, H. Schnoedt, G. Tew, S. Tomer, and P. Zellner-Bassett
Assistant Professors: A. Algargoosh, L. Borunda Monsivais, G. Cannici, A. Gipe-Lazarou, R. Haghnazar, G. Muñoz-Vera, E. Keslacy, N. King, K. Washco, and C. Williamson
Collegiate Associate Professor: R. Pieper, C. Pritchett
Collegiate Assistant Professor: C. Vorster
Associate Professor of Practice: K. Jones
Visiting Associate Professors of Practice: B. Green, and C. Von Wiese
Visiting Assistant Professors of Practice: M. Cook, E. Garcia, D. Haney, J. Hernandez, A. Linn, B. Pennell, D. Regan
Adjunct Instructors: R. Daniel, D. Dea, T. Green, D. Lever, P. MacDowell, R. Mars, A. Shaver, K. Sullivan, and J. Syvertsen
Professor Emeritus: W. Brown, R. Chiang, S. Choudhury, R. Daniel, A.J. Davis, D. Dunay, D. Egger, L. Ferrari, J. Holt, W. Kark, S. Poole, H. Rodriquez-Camilloni, H. Rott, F. Ruiz, R. Schubert, D. Sunshine, S. Thompson, and J. Wang
Associate Professor Emeritus: M. Cortes, M. Feuerstein, and D. Jones
Assistant Professor Emerita: E. Braaten

Undergraduate Course Descriptions (ARCH)

ARCH 1004 - Understanding Community through your Campus (2 credits)
The Virginia Tech campus as both a place and an idea. Explore the physical campus and learn how to recognize its elements. Determine where you are physically, as a community, and as part of an academic tradition. Identification of campus landmarks and navigational exploration. Measure and assess the campus and its spaces and objects, both real and virtual. Place this campus in relation to wider campus ideal and Virginia Tech history. Discussion of custodianship of land by indigenous people and history of black communities in Blacksburg and surrounding areas. Discussion of how and to whom the campus is accessible. Analysis of its buildings, spaces, and branded artifacts in verbal, digital, and drawn representation of the images, forms, and spaces students have observed. Recognition and analysis of both explicit and implicit messages in buildings, objects, and spaces. Come to an understanding of how human-made structures act as stage sets or active frameworks in which we can act out our roles of as members of communities of various kinds and at various scales.
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 1015 - Foundation Design Laboratory (6 credits)
Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgement and critical understanding. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ARCH 1016 - Foundation Design Laboratory (6 credits)
Foundation Design Lab is an immersive, interactive learning environment focused on inquiry, experimentation, discovery, and synthesis for students studying architecture, landscape architecture, interior design, and industrial design. The design lab develops self-reliance and self-critique, opens intellectual horizons, and challenges students to continually expand and deepen their aesthetic judgement and critical understanding. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ARCH 1024 - Innovative Design Thinking (3 credits)
Engages students in learning environment of the design laboratory, which is interactive inquiry, experimentation, discovery, and synthesis. Develops thinking and making skills in 2D and 3D across multiple scales. Advances abilities to solve problems through exploring strategies with viable consequences. Engages students in a series of iterative drawing, and modeling exercises relevant to architecture and design education. ARCH 1024 is restricted to incoming freshmen.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 1034 - Seeing Design: Transforming Observations (3 credits)
Introduces students to ways of perceiving, and recording the built and natural environment in Southwest Virginia. Introduces students to travel studies as an essential part of their architecture and design education. Transforms students observational skills. Employs photography and sketching as means of documenting findings. Employs screenprinting and digital technologies as a way to transform documentation. Prepares students for an exhibition of their work, including oral presentations. ARCH 1034 is restricted to incoming freshmen.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 1044 - Life in the Built Environment (3 credits)
Development of the human-made environment has shaped our social relations, culture, and identity. Discussion of how the imposition of built form has served both to define a shared culture and as a means of exclusion and injustice. Study of equity and ethics as evidenced and continued in planning, construction, and public space. Learn how the knowledge of these past structures might shape the future of the built environment in the United States in ways that are more equitable, inclusive, and sustainable.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 1044

ARCH 1115 - Qualifying Design Laboratory (3 credits)
1115: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at a beginners level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgment and critical understanding. Develops fundamental thinking and making skills that advance their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design. 1116: An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at an intermediate level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgement and critical understanding. Advances foundational thinking and making skills that develop their abilities to solve problems by exploring strategies toward viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ARCH 1116 - Qualifying Design Laboratory (3 credits)
An immersive, interactive course focused on inquiry, experimentation, discovery, and synthesis. Employs a series of iterative drawing and modeling exercises, at an intermediate level, in two and three dimensions across multiple scales. Develops self-reliance and self-critique, which opens intellectual horizons. Challenges expand and deepen aesthetic judgement and critical understanding. Advances foundational thinking and making skills that develop their abilities to solve problems by exploring strategies towards viable consequences. Restricted to students transferring into the School of Architecture + Design and changing their major to architecture, landscape architecture, interior design, or industrial design.
Prerequisite(s): ARCH 1115
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ARCH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 2004 - Architecture and Culture: Buildings, Equity and Climate (3 credits)
Interdisciplinary and cross-cultural study of architecture and its context - fundamental architectural ideas, how and why buildings are built, how spaces are occupied and by whom, and how external forces (such as social, political, economic, and environmental) inform architecture's construction and occupation. Examine key buildings from cultures around the world through architectural artifacts, texts, and drawings, employing both disciplinary and interdisciplinary perspectives. Analyze how these buildings operated within diverse cultures to investigate the mutual influence between architecture and its context over time. Develop coherent, evidence-based arguments, drawing on insights from both discipline-specific and interdisciplinary approaches. Develop recommendations for inclusive, equitable, and climate-responsive architecture.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 2015 - Architecture II (7 credits)
Introduction to the theory and practice of architecture. Discipline-specific investigations into how architecture concentrates and conveys natural and cultural influences. Focus on building design as a comprehensive activity balancing numerous concerns including aesthetic, history, materiality, tectonics, and spatial expression. Examination of the relationship between the built and natural environments, including the effects of construction and environmental factors. Qualitative approaches to how architecture contributes to human wellbeing. Identification of relevant areas of interest and modes of inquiry to enrich current work and serve as a basis for self-directed learning. Immersion in the design laboratory ('studio') learning environment. 2015: How architecture concentrates and expresses natural and cultural influences, as well as how it addresses the well-being of individuals and society, through design investigations of varied scales and complexity. Identifying and connecting the fundamentals that comprise the multidimensional wholeness of a work of architecture. Selecting, describing, and analyzing relevant precedents. How architecture and the arts are similar and different, as well as how different fields of knowledge relate to architecture as a cultural and technological production. Discipline-specific modes of communication. 2016: Continued exploration of the dynamic between built and natural environments, including site, environmental forces, and construction impacts; how architecture contributes to human wellbeing. Speculation, development, and communication of architectural proposals. Developing creative source materials by examining a problem from various disciplinary and cultural perspectives. Increasingly complex design work. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 2016 - Architecture II (7 credits)
Introduction to the theory and practice of architecture. Discipline-specific investigations into how architecture concentrates and conveys natural and cultural influences. Focus on building design as a comprehensive activity balancing numerous concerns including aesthetic, history, materiality, tectonics, and spatial expression. Examination of the relationship between the built and natural environments, including the effects of construction and environmental factors. Qualitative approaches to how architecture contributes to human wellbeing. Identification of relevant areas of interest and modes of inquiry to enrich current work and serve as a basis for self-directed learning. Immersion in the design laboratory ('studio') learning environment. 2015: How architecture concentrates and expresses natural and cultural influences, as well as how it addresses the well-being of individuals and society, through design investigations of varied scales and complexity. Identifying and connecting the fundamentals that comprise the multidimensional wholeness of a work of architecture. Selecting, describing, and analyzing relevant precedents. How architecture and the arts are similar and different, as well as how different fields of knowledge relate to architecture as a cultural and technological production. Discipline-specific modes of communication. 2016: Continued exploration of the dynamic between built and natural environments, including site, environmental forces, and construction impacts; how architecture contributes to human wellbeing. Speculation, development, and communication of architectural proposals. Developing creative source materials by examining a problem from various disciplinary and cultural perspectives. Increasingly complex design work. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 2034 - Art of Building (2 credits)
Introduction to architecture identifying the fundamental considerations that contribute to the complex totality of a work of architecture. Interrelationships of context, structure, materiality, and technology toward accommodation and advancement of human activities and well-being. Context as preexisting factors and forces of any given site of architecture, not limited to cultural, historical, geographical, and environmental, including topography and climate. Contemporary precedents emphasizing the diversity of cultural practices and values around the globe.
Prerequisite(s): ARCH 1016
Corequisite(s): ARCH 2015
Instructional Contact Hours: (3 Lab, 2 Crd)

ARCH 2044 - Building Materials (2 credits)
Introduction to the attributes of materials with which buildings are built such as masonry, reinforced concrete, steel, stone, timber, glass and insulation; introduction of the impact of soil, vegetation, watersheds and other natural conditions on buildings and their material fabrication.
Prerequisite(s): ARCH 1015
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 2114 - Sustainability by Design (3 credits)
Design decision-making in complex contexts. Ethical issues underlying design for sustainability. Evaluation of design in systems, products, places, and modes of living using the Framework for Strategic Sustainable Development (FSSD). Historical and cultural underpinnings of design and sustainability.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2114

ARCH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3015 - Architecture III (7 credits)
Architectural design principles, technical concepts, applications, and measures of quality. Ongoing development of key professional skills such as modes of inquiry, problem structuring, drawing and modeling, workflows, and critique. Site, program, structural, regulatory, and environmental influences addressed in architectural formulations. Development of independent interests, research pursuits, and modes of working. 3015: Various materials and techniques of building design. The technical language of describing designed structures. Human experience, health & wellness, user needs, and regulatory standards in the built environment at multiple scales. Analysis of programmatic and site variables that influence design decisions and resource and environmental stewardship objectives. How fundamental design concepts (idea, movement, structure) and human occupation (context, program, experience) intersect with technical constructive knowledges (assembly, materials, building systems). Subjective measures of quality in design. 3016: Continued studies in materials and techniques of building design. Building assemblies documented in technical drawing, modeling, and writing. Interweaving of fundamental design concepts, human occupation, and technical constructive knowledges. How subjective and measurable (resource, environmental stewardship) criteria impact design decisions. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 2016
Corequisite(s): ARCH 3065
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 3016 - Architecture III (7 credits)
Architectural design principles, technical concepts, applications, and measures of quality. Ongoing development of key professional skills such as modes of inquiry, problem structuring, drawing and modeling, workflows, and critique. Site, program, structural, regulatory, and environmental influences addressed in architectural formulations. Development of independent interests, research pursuits, and modes of working. 3015: Various materials and techniques of building design. The technical language of describing designed structures. Human experience, health & wellness, user needs, and regulatory standards in the built environment at multiple scales. Analysis of programmatic and site variables that influence design decisions and resource and environmental stewardship objectives. How fundamental design concepts (idea, movement, structure) and human occupation (context, program, experience) intersect with technical constructive knowledges (assembly, materials, building systems). Subjective measures of quality in design. 3016: Continued studies in materials and techniques of building design. Building assemblies documented in technical drawing, modeling, and writing. Interweaving of fundamental design concepts, human occupation, and technical constructive knowledges. How subjective and measurable (resource, environmental stewardship) criteria impact design decisions. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 3015
Corequisite(s): ARCH 3066
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 3054 - Building Analysis (2 credits)
Study of exemplary built works of architecture through analysis of design documents, interviews, and inspection of actual construction. Course is completed as a group project resulting in both an oral presentation and a written document.
Prerequisite(s): ARCH 3015
Corequisite(s): ARCH 3016, ARCH 3046
Instructional Contact Hours: (2 Lec, 2 Crd)

ARCH 3065 - Building Materials and Assemblies (3 credits)
Study of what buildings are made of and how buildings are made, in support of architectural design decisions. Attributes of building materials informing their selection and use in buildings. Design and representation of building assemblies, systems, and details, including primary and secondary structural systems, the building envelope, and sub-assemblies, as influenced by formal design ideas, geometry, structure, construction processes, weather resistance, human health and well-being, and environmental impact and sustainability. 3065: Focus on wood, masonry, concrete, and steel construction systems; subsurface conditions and foundations; building codes, life-safety, and accessibility; and basic principles of building envelope systems. 3066: Review of wood, masonry, concrete, and steel construction. Focus on design of building envelope/enclosure wall systems and roofs, including consideration of water resistance, thermal insulation, air infiltration, and vapor control; building cost considerations; and appropriate modes of representation for detailed design decisions.
Prerequisite(s): ARCH 2016
Corequisite(s): ARCH 3015
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3066 - Building Materials and Assemblies (3 credits)
Study of what buildings are made of and how buildings are made, in support of architectural design decisions. Attributes of building materials informing their selection and use in buildings. Design and representation of building assemblies, systems, and details, including primary and secondary structural systems, the building envelope, and sub-assemblies, as influenced by formal design ideas, geometry, structure, construction processes, weather resistance, human health and well-being, and environmental impact and sustainability. 3065: Focus on wood, masonry, concrete, and steel construction systems; subsurface conditions and foundations; building codes, life-safety, and accessibility; and basic principles of building envelope systems. 3066: Review of wood, masonry, concrete, and steel construction. Focus on design of building envelope/enclosure wall systems and roofs, including consideration of water resistance, thermal insulation, air infiltration, and vapor control; building cost considerations; and appropriate modes of representation for detailed design decisions.
Prerequisite(s): ARCH 3065
Corequisite(s): ARCH 3016, ARCH 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3115 - Histories of Architecture (3 credits)
Disciplinary study of architecture across time (pre-history to present) and across continents (Eastern, Western, Northern, and Southern hemispheres). Histories, principles, and factors grounding architecture's expression, form, and methods. Architecture as a cultural production reflective of its social, political, artistic, intellectual, technological, and environmental context. Exploration through artifacts, texts, drawings. ARCH 3115: emphasis on artifacts and architecture between 25000 BCE and 1600 CE; ARCH 3116: includes architectural productions from 1600 CE to present.
Prerequisite(s): ARCH 1015
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3116 - Histories of Architecture (3 credits)
Disciplinary study of architecture across time (pre-history to present) and across continents (Eastern, Western, Northern, and Southern hemispheres). Histories, principles, and factors grounding architecture's expression, form, and methods. Architecture as a cultural production reflective of its social, political, artistic, intellectual, technological, and environmental context. Exploration through artifacts, texts, drawings. ARCH 3115: emphasis on artifacts and architecture between 25000 BCE and 1600 CE; ARCH 3116: includes architectural productions from 1600 CE to present.
Prerequisite(s): ARCH 3115
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 3204 - Topics Modules in Architecture History & Theory (1 credit)
Discrete topics in design theory, history, criticism, research methods, and representation. How historic, social, political, technological, and/or economic factors shape the built environment. Historical and contemporary significance of architectural productions within cultural dimensions of human history. How discrete modes of verbal, textual, visual, graphic, or spatial representation influence and reflect understanding relative to architectural form and ideas. May be repeated 2 times with different content for a maximum of 3 credit hours.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3214 - Topic Modules in Building Science and Technology (1 credit)
Focused topics in building technology, systems, materials, construction, assembly and details. Develop scientific expertise that couples quantitative and qualitative dimensions using tools, methods, science, processes of the given field through study, reflection, and application. Utilize empirical knowledge, including building performance, environmental responsibility, and occupant well-being, to advance design excellence. May be repeated 2 times with different content for a maximum of 3 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3224 - Topics Modules in Architectural Media and Methods (1 credit)
Properties and uses of media, materials and processes as tools for analysis, documentation, and presentation of the designed environment. Media properties and processes. Selection of workflows. Appropriate use and maintenance of tools. Iterative design and evaluating outcomes. May be repeated 2 times with different content for a maximum of 3 credit hours. Design Lab/Studio (2L, 1C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (2 Lab, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3234 - Topics Modules in Architecture and Praxis (1 credit)
Specialized topics in the practice of architecture related to designing, planning, and managing the built environment. Factors that inform and impact both design processes and outcomes, such as environmental justice, professionalism, sustainability, inclusivity, and technology. Established and emerging frameworks of architectural practice in fostering the continuous improvement of the discipline. How architects and architecture can contribute to a variety of academic and professional contexts. Teamwork and leadership. May be repeated 2 times with different content for a maximum 3 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

ARCH 3304 - Topics in Architecture History & Theory (3 credits)
Discrete topics in architecture theory, history, criticism, research methods, and representation. How historic, social, political, technological, and economic factors shape the built environment. Historical and contemporary significance of architectural productions within cultural dimensions of human history. The works and ideas of architects, urban planners, historians, theorists, and educators in the context of contemporary architecture. Critical discourse and inquiry. May be repeated 2 times with different content for a total of 9 credit hours.
Prerequisite(s): ARCH 3116
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 3404 - Topics in Building Science and Technology (3 credits)
Focused topics in building technology, systems, materials, construction, assembly and details. Develop scientific expertise that couples quantitative and qualitative dimensions using empirical and design-based tools, methods, science, processes of the given field through study, reflection, and application. Research methods. Representing and communicating research objectives and findings. Using findings to inform decision-making in design. May be repeated 2 times with different content for a maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 3504 - Topics in Architectural Media and Methods (3 credits)
Topics in properties and uses of media, materials, and processes as tools for craft, analysis, documentation, and presentation of the designed environment. Media properties, materials and processes. Selection of workflows. Appropriate use and maintenance of tools. Interplay between media properties and workflows. Iterative design and evaluating outcomes. Parallel practices, techniques, and structures of thinking and making. May be repeated 1 time with different content for a maximum of 6 credit hours. Design Lab/Studio (1H, 3L, 3C)
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 3604 - Topics in Architecture and Praxis (3 credits)
Specialized topics in the practice of architecture related to designing, planning, and managing the built environment. Develop professional expertise with the knowledge, tools, and processes of the given topic through study, use, and reflection. Existing and emerging theories and frameworks that govern the practice of architecture and its outcomes in the constructed environment. Tools, methods, and practices towards the design of responsive, inclusive, and sustainable works of architecture. Position taken on an individual level within the profession of architecture. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 2015
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ARCH 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4004 - Architecture IV - Option Lab (7 credits)
Advanced architecture laboratory with specialized design options, off-campus domestic and study abroad opportunities, technical research, and professional internships. Role of design processes in shaping the built environment in response to multiple factors and across diverse contexts. Immersion in professional or specialized settings to contextualize the student's position in the discipline. Development of student-driven course of action for pursuing ongoing professional interests through engagements with, and contributions to, disciplinary research and discourse. Engagement of new territories of inquiry and representation in design work. Critical professional skills in documentation of technical and discursive dimensions of architectural works. Hybrid Lecture (2H, 2C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (2H,14L,7C)
Prerequisite(s): ARCH 3016
Instructional Contact Hours: (2 Lec, 14 Lab, 7 Crd)

ARCH 4014 - Architecture IV - Integrative Design (8 credits)
Integration of site, program, constructive systems, and regulatory and environmental frameworks to develop conceptually sound and technically feasible architectural works. Application of design research, including precedent analysis and case studies of existing works. Advanced representation techniques including written, graphic, and physical artifacts. Criticism and dialogue. Individual growth in areas of ongoing interest, research, and modes of study in architectural practice. Repeatable one time, Max. 16 cr. Hybrid Lecture (2H, 2C), Lab (15L, 5C), Design Lab/Studio (2L, 1C) (2H, 17L, 8C)
Prerequisite(s): ARCH 3016 and ARCH 3054
Instructional Contact Hours: (2 Lec, 17 Lab, 8 Crd)
Repeatability: up to 16 credit hours

ARCH 4034 - Building Cities (3 credits)
Analytical studies in the historical evolution of cities, towns and villages. Comparative studies of urban form in relation to their constructive and imaginative means with an emphasis on modern construction processes. Specific case studies in designing and building cities.
Corequisite(s): ARCH 4016
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4044 - Professional Practice in Architecture (3 credits)
Role and responsibilities of the profession on the environment, public health, and social welfare. Professional ethics. Contributions to policymaking and the building enterprise through leadership, advocacy, and civic engagement. Issues of equity, diversity, and inclusion in the profession, the environments where we practice, and the places we design. Roles, responsibilities and viewpoints of the commissioning, design, and construction ensemble. Contracts, compliance, and risk management. Starting, running, and maintaining a profitable architecture practice to achieve design goals. Methods and technologies for delivering projects. Leadership and professional communication skills, including oral, written, and visual presentations, negotiations and conflict resolution, and interpersonal communication in collaborative teams, interviews, and public meetings. Pursuing licensing, specialization, and/or nontraditional career trajectories. Change and future practice forms.
Prerequisite(s): ARCH 3016
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4055 - Environment and Building Systems (3 credits)
A design oriented study of environmental forces, environmental impacts of the built environment, and related building environmental control, life safety and service systems, with concern for the human psycho-physical impacts of building form and systems performance.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4056 - Environment and Building Systems (3 credits)
A design oriented study of environmental forces, environmental impacts of the built environment, and related building environmental control, life safety and service systems, with concern for the human psycho-physical impacts of building form and systems performance.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4075 - Building Structures (3 credits)
Building structures in steel, timber, and reinforced concrete; design of typical components: beams, slabs, columns, beam-columns, connections, and foundations; design of retaining walls; the resistance of buildings to gravity and lateral force action; building stability; floor/roof framing systems; design of simple buildings.
Prerequisite(s): ESM 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4076 - Building Structures (3 credits)
Building structures in steel, timber, and reinforced concrete; design of typical components: beams, slabs, columns, beam-columns, connections, and foundations; design of retaining walls; the resistance of buildings to gravity and lateral force action; building stability; floor/roof framing systems; design of simple buildings.
Prerequisite(s): ESM 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4114 - Ideas, Concepts, and Representations of Architecture (3 credits)
Disciplinary study of ideas, concepts, and representations that have shaped architecture across time (Common Era). Emphasis on ideational constructs and their varied modes of transmission (from textual to oral communications, drawings to images, buildings to models) in relation to the projecting of architecture. Architectural theories and their transmission as cultural productions reflective of societal, ethical, intellectual, environmental, and technological contexts. Presentation and reflection upon architectural discourse itself through written and oral communication.
Prerequisite(s): ARCH 3015 and ARCH 3116
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4124 - Advanced Topics in Architecture History & Theory (3 credits)
Advanced design theory, history, critique, study, and representation. How history, politics, technology, and economics affect architecture and the built environment. Architectural significance. Architectural social, economic, and cultural content. Direct observation, reading, and discourse in architectural criticism. Course may be repeated with different content 2 times for a maximum of 9 credit hours.
Prerequisite(s): (ARCH 3204 or ARCH 4114) and ARCH 3304
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 4144 - Advanced Building Structures I (3 credits)
Study of long-span building structures. Introduction to geometry, form, and structure of folded and bent surfaces. Study of space grid geometry, close-packing systems, and cellular tensegrity. Approximate design of folded plate structures, single and double curvature shells, single and double layer space frames, suspension roofs, tents, and pneumatic structures.
Prerequisite(s): ARCH 4075 and ARCH 4076
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4154 - Advanced Building Structures II (3 credits)
Study of highrise structures ranging from building slabs and blocks, terraced buildings, and skyscrapers to towers. The complexity of load action including wind, earthquake, and hidden loads. The effect of building height, form, and proportion on force action; considerations of stability and redundancy. Preliminary design of masonry buildings, core structures, suspension buildings, braced skeletons, rigid frames, interstitial systems, staggered truss buildings, tubes and hybrid structures.
Prerequisite(s): ARCH 4075 and ARCH 4076
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4224 - Advanced Topics in Building Science and Technology (3 credits)
Advanced topics in building technology, systems, materials, construction, assembly and details. Develop expertise that couples quantitative and qualitative dimensions using tools, methods, science, processes of the given field through study, reflection, application and dissemination of findings. Norms of communicating findings. Applying research findings to design. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4324 - Advanced Topics in Architectural Media and Methods (3 credits)
Advanced topics in architectural media, materials, and processes as tools for analysis, documentation, and presentation of the designed environment. Relationship between media characteristics and processes, applied to a wide range of media types and areas of study. Selection of appropriate tools and workflows. Managing and maintaining toolsets and workspaces. Forms of design research and innovation. Iterative design and evaluating outcomes. Creative practice and discourse. May be repeated 1 time with different content for a maximum of 6 credit hours. Design Lab/Studio (1H, 3L, 3C).
Prerequisite(s): ARCH 3504
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4414 - Advanced Environment Building Systems (3 credits)
Advanced studies of environment and building systems, including development in building systems, urban systems, service systems, construction systems, materials and component systems, psycho-physical considerations, systems analysis, and computer technology. May be repeated for a maximum of 9 credit hours in varied options offered.
Prerequisite(s): ARCH 4055 and ARCH 4056
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ARCH 4424 - Advanced Topics in Architecture and Praxis (3 credits)
Advanced topics in the practice of architecture related to designing, planning, and managing the built environment. Innovative knowledge, frameworks, and models for an increasingly just, adaptable, and built environment and profession. Alternative approaches to defining, creating, and value for clients, communities, and employees. May be repeated 1 time with different content for a maximum of 6 credit hours.
Prerequisite(s): ARCH 4044
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ARCH 4434 - Architectural Lighting Design (3 credits)
Advanced level lecture course focused on lighting. Impact on, need for and measurement of light for humans and the built and natural environments. Selection of color, light sources, equipment and controls. daylight integration. Lighting design, visualization and calculations through hand and digital methods. Evaluation of lighting system energy efficiency and cost. Presentation of lighting design.
Prerequisite(s): ARCH 4055 and ARCH 4056
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4514 - Thesis Inquiry (3 credits)
Student-led, design thesis project research articulated by an aggregated, reflective record of the first semester design work of ARCH 4515-4516 (Architecture V) through an appropriate array of representational means, such as writing, models, images, and drawings. Schematic, critical compilation of ideational and physical process includes critique, evaluation, and presentation of historical, contextual, professional, ethical, and aesthetic considerations; conceptual and theoretical foundations; development of the project's parameters and its design. Course contact to credit hour structure: Lecture (1H, 1C), Lab (3L, 1C), Design Lab/Studio (1.5L, 1C).
Prerequisite(s): ARCH 4004 and ARCH 4014
Corequisite(s): ARCH 4515
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Lab, 3 Crd)

ARCH 4515 - Architecture V (6 credits)
Advanced design and research to produce an architectural project. Demonstration of a conceptual and professional position through a work of architecture. 4515: Student-led focus on identifying research field; probing professional interests; developing conceptual and project parameters; proposing and evaluating design through varied means of public dialogue, critique, and self-reflection. 4516: Emphasis on resolution of project, formal documentation and presentation of work, communication of conceptual position, and assertion of professional trajectory. Hybrid Lecture (1H,1C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (1H,14L,6C)
Prerequisite(s): ARCH 4004 and ARCH 4014
Corequisite(s): ARCH 4514
Instructional Contact Hours: (1 Lec, 14 Lab, 6 Crd)

ARCH 4516 - Architecture V (6 credits)
Advanced design and research to produce an architectural project. Demonstration of a conceptual and professional position through a work of architecture. 4515: Student-led focus on identifying research field; probing professional interests; developing conceptual and project parameters; proposing and evaluating design through varied means of public dialogue, critique, and self-reflection. 4516: Emphasis on resolution of project, formal documentation and presentation of work, communication of conceptual position, and assertion of professional trajectory. Hybrid Lecture (1H,1C), Lab (12L, 4C), Design Lab/Studio (2L, 1C) (1H,14L,6C)
Prerequisite(s): ARCH 4514 and ARCH 4515
Corequisite(s): ARCH 4524
Instructional Contact Hours: (1 Lec, 14 Lab, 6 Crd)

ARCH 4524 - Thesis Documentation (3 credits)
Formal documentation of the architectural design thesis, a terminal design project with a conceptual and professional position in the final, fifth year of the professional degree program. Thesis project, process, concept, research, and ethical position presented through drawings, images, and writings. Preparation of portfolio quality document demonstrating architectural ability within discipline and profession. Course contact to credit hour structure: Lecture (1H, 1C), Lab (3L, 1C), Design Lab/Studio (1.5L, 1C).
Prerequisite(s): ARCH 4514 and ARCH 4515
Corequisite(s): ARCH 4516
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ARCH 4705 - Qualifying Design Seminar (3 credits)
Exploratory overview of selected theories and issues relevant to the design and use of the environment. 4705: Emphasis on history, human behavior, and environmental context as it relates to architecture. 4706: Presentation and discussion of the nature of principal construction materials in relation to building design. Characteristics of primary structural materials: wood, steel, concrete, masonry; environmental control systems; supporting technologies. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4706 - Qualifying Design Seminar (3 credits)
Exploratory overview of selected theories and issues relevant to the design and use of the environment. 4705: Emphasis on history, human behavior, and environmental context as it relates to architecture. 4706: Presentation and discussion of the nature of principal construction materials in relation to building design. Characteristics of primary structural materials: wood, steel, concrete, masonry; environmental control systems; supporting technologies. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 3 Crd)

ARCH 4715 - Qualifying Design Laboratory (9 credits)
4715: Design laboratory in which student and faculty teams explore the nature of problems and potentials with which architecture is concerned, and experimentally develop methods and process through which existing contexts are transformed into new conditions. 4716: Provides introduction to basic concepts of building structures, materials, and enclosure systems, and appropriate site and climate responses. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 18 Lab, 9 Crd)

ARCH 4716 - Qualifying Design Laboratory (9 credits)
4715: Design laboratory in which student and faculty teams explore the nature of problems and potentials with which architecture is concerned, and experimentally develop methods and process through which existing contexts are transformed into new conditions. 4716: Provides introduction to basic concepts of building structures, materials, and enclosure systems, and appropriate site and climate responses. Not for credit for majors holding a first professional degree in architecture.
Instructional Contact Hours: (3 Lec, 18 Lab, 9 Crd)

ARCH 4904 - Professional Studies (1 credit)
Instructional Contact Hours: (1 Lec, 1 Crd)

ARCH 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ARCH 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Architecture Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Architecture Degree Core Courses		
ARCH 2015	Architecture II [1]	7
ARCH 2016	Architecture II [1]	7
ARCH 3015	Architecture III [1]	7
ARCH 3016	Architecture III [1]	7
ARCH 4004	Architecture IV - Option Lab [1]	7
ARCH 4014	Architecture IV - Integrative Design [1]	8
Subtotal		43
Major Requirements		
ARCH 1015	Foundation Design Laboratory	6
ARCH 1016	Foundation Design Laboratory	6
ARCH 2034	Art of Building [1]	2
ARCH 3054	Building Analysis [1]	2
ARCH 3065	Building Materials and Assemblies [1]	3
ARCH 3066	Building Materials and Assemblies [1]	3
ARCH 3900	Bridge Experience [2]	0
ARCH 4034	Building Cities [1]	3
ARCH 4044	Professional Practice in Architecture	3
ARCH 4055	Environment and Building Systems	3
ARCH 4056	Environment and Building Systems	3
ARCH 4075	Building Structures [1]	3
ARCH 4076	Building Structures [1]	3
ARCH 4515	Architecture V [1]	6
ARCH 4516	Architecture V [1]	6
ESM 3704	Basic Principles of Structures	3
Subtotal		55
Professional Electives		
Select six credits of professional elective courses choosing from the list of approved courses below:		6
ARCH 2954		
ARCH 3304	Topics in Architecture History & Theory	
ARCH 3504	Topics in Architectural Media and Methods	
ARCH 3604	Topics in Architecture and Praxis	
ARCH 3954	Study Abroad	
ARCH 4124	Advanced Topics in Architecture History & Theory	
ARCH 4144	Advanced Building Structures I	
ARCH 4154	Advanced Building Structures II	
ARCH 4204		
ARCH 4324	Advanced Topics in Architectural Media and Methods	
ARCH 4414	Advanced Environment Building Systems	
ARCH 4424	Advanced Topics in Architecture and Praxis	
ARCH 4434	Architectural Lighting Design	
ARCH 4954	Study Abroad	
Subtotal		6
Free Electives		
Select 11 credits of free electives [3]		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
ENGL 1106	First-Year Writing	3
ARCH 4114	Ideas, Concepts, and Representations of Architecture (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
ARCH 3115	Histories of Architecture (in Major Required Course)	3
ARCH 3116	Histories of Architecture (in Major Required Course)	3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1535	Geometry and Mathematics of Design	3
or MATH 1225	Calculus of a Single Variable	
MATH 1536	Geometry and Mathematics of Design	3
or MATH 1226	Calculus of a Single Variable	
Select three credits of Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
ARCH 4514	Thesis Inquiry (6A) [4]	3
ARCH 4524	Thesis Documentation (6D) [4]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		3
Subtotal		45
Total Credits		**160**

1. **Prerequisite/Corequisite:** Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.
2. The Bridge Experience is the application of academic knowledge and skills to a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre-approval of a 3900 bridge plan is required after the first year. Register for the semester that corresponds with the beginning of the Bridge Experience.
3. It is recommended that free elective credits be taken at the 2000-level and higher.
4. ARCH 4514 Thesis Inquiry and ARCH 4524 Thesis Documentation each satisfy 3cr. Arts / 3 cr. Design under Pathways to Gen. Ed. Concept 6.
5. Critical Analysis of Identity & Equity in the US may be double counted with another core outcome.

Industrial Design

Our Website (http://www.industrialdesign.arch.vt.edu/)

Overview

As described by the Industrial Designers Society of America, "Industrial Design (ID) is the professional service of creating and developing concepts and specifications that optimize the function, value and appearance of products and systems for the mutual benefit of both user and manufacturer.

Industrial designers develop these concepts and specifications through collection, analysis and synthesis of data guided by the special requirements of the users, client and manufacturer. They are trained to prepare clear and concise recommendations through drawings, models and verbal descriptions.

Industrial design services are often provided within the context of cooperative working relationships with other members of a development group. Typical groups include management, marketing, engineering and manufacturing specialists. The industrial designer expresses concepts that embody all relevant design criteria determined by the group.

The industrial designer's unique contribution places emphasis on those aspects of the product or system that relate most directly to human characteristics, needs and interests. This contribution requires specialized understanding of visual, tactile, safety and convenience criteria, with concern for the user. Education and experience in anticipating psychological, physiological and sociological factors that influence and are perceived by the user are essential industrial design resources."

The internationally recognized program at Virginia Tech, fully accredited by the National Association of Schools of Art and Design, prepares individuals to enter this dynamic field through a rigorous curriculum and an experienced, dedicated faculty.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in Industrial Design.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Industrial Design Major (p. 596)

Associate Professor of Practice and Chair: Martha Sullivan
Associate Professors: W. Green and B. Kennedy
Assistant Professors: J. Hauptman and E. Morshedzadeh
Adjunct Professor: B. Kirkland
Professor Emeritus: R. Kemnitzer and E. Dorsa

Undergraduate Course Descriptions (IDS)

IDS 1114 - Play to Make (3 credits)
Transdisciplinary practice in an inclusive, collaborative environment, through the lens of design, technology and creative expression, to describe and evaluate the convergence between art, technology, and human experience in the arts, sciences, humanities, and engineering. Exploration of play for creation of ideas and artifacts (including, but not restricted to multimedia narratives, learning simulations, immersive/performative experiences, and data exploration). Inclusive collaboration with peers and practicing professionals in diverse fields. Critical consideration of art and design and the impacts on history, society, cultures, individuals, and communities. Collaborative research, design, creation, and exhibition of a transdisciplinary project to identify and address a global challenge.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2015 - Industrial Design Laboratory II (5 credits)
Introduction to the discipline of Industrial Design. Emphasis on form generation, including: design theory, problem solving methodologies, conceptualization of ideas, and aesthetic sensibility. Secondary emphasis on skill development in 2 and 3 dimensions: awareness of materials and manufacturing processes, storyboarding, model making, written documentation of design process, and verbal presentation. IDS 2015 is taught in conjunction with IDS 3224: Topics in Design Competencies: Workshop and IDS 2065: Visual Design.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 7 Lab, 5 Crd)

IDS 2016 - Industrial Design Laboratory II (6 credits)
Introduction to the discipline of Industrial Design. Emphasis on form generation, including: design theory, problem solving methodologies, conceptualization of ideas, and aesthetic sensibility. Secondary emphasis on skill development in 2 and 3 dimensions: awareness of materials and manufacturing processes, storyboarding, model making, written documentation of design process, and verbal presentation. IDS 2015 is taught in conjunction with IDS 3224: Topics in Design Competencies: Workshop and IDS 2065: Visual Design.
Prerequisite(s): IDS 2015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 2034 - Design Visualization (3 credits)
Visual communication, modes of representation techniques, freehand drawings, perspectives, axonometric techniques, computer modeling, and form analysis. Presentation of ideas through rapid sketching and communicating resolved designs through detailed hand drawings. Development of portfolio and skills to choose appropriate methods for tasks.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2044 - Human Factors (3 credits)
This course examines human factors as it informs the design process, and as a tool to maximize the physical and psychological aspects of design toward the establishment of a human centered design. Frameworks of industrial design philosophy, research methods, standards and data, human issues, cultural context, and design outcomes.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2114 - History of Industrial Design (3 credits)
Broad movements in the history of art and industrial design. Application and analysis of art and design elements, principles, and composition techniques. Materials, processes, and innovations in art and design in context of culture, geography, and perspective.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2124 - History of Modern Industrial Designers (3 credits)
Introduction to modern industrial design. Elements, principles, and composition techniques in art and design. Major movements from the 20th-century and how the values, ideals, and styles of designers influence the evolution of design. Comparative study of objects, design theory, and methodologies related to the changes in the profession and global perspectives.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2214 - IDS Studio for Minors (6 credits)
Introduction to the discipline and the critical elements that contribute to the complexity of a work of design. Emphasis on intellectual discipline, skills development, communication of ideas, materials research, and a self-motivated search for critical issues. For registered Industrial Design Minors only.
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 2304 - Computer Aided Industrial Design (3 credits)
An introduction to computer aided two and three- dimensional design and modeling as applied in industrial design using both solid and surface software modeling techniques.
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 3015 - Industrial Design Laboratory III (6 credits)
Introduction to systematic processes in design. Introduction and application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods.
Prerequisite(s): IDS 2016
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 3016 - Industrial Design Laboratory III (6 credits)
Introduction to systematic processes in design. Introduction and application of Human Factors and systematic planning methods in the development of industrial products in the areas of work, education and health. Development of professional presentation skills and methods.
Prerequisite(s): IDS 3015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 3124 - Materials and Processes (3 credits)
Current design processes, materials, manufacturing processes, techniques, and equipment used in the design of products for mass and rapid production. Variety of materials and manufacturing processes available to the industrial designer for mass production impact his/her design process. Emphasis placed on the relationship of processes and equipment, to the environment and the end user. Includes concepts of material science. Practical issues of material selection and application, process selection, and specification.
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 3204 - Topics in Professional Development (1-19 credits)
Issues of practicing in an industrial design professional environment: public speaking, portfolio presentation, client/civic engagement (service learning), interdisciplinary teamwork and leadership in the development process of industrial products. Repeatable with instructor permission. Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3224 - Topics in Design Competencies (1-19 credits)
Issues of industrial design competencies and expertise required in a professional design environment, for example: software; model making (both hand making and digital rapid prototyping); workshop (wood, metal and plastics); specialized product design areas (packaging, furniture or exhibit design). Repeatable with instructor permission Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3234 - Topics in Design Theory (1-19 credits)
Issues of industrial design theory required for advancement in a professional design environment, for example: Product Semantics; Design Ethics; EcoDesign/Sustainability; Universal Design. Repeatable with instructor permission. Variable credit and duration.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 3514 - Design Research (3 credits)
The course looks at the question of research and the ongoing exercise of re-definition for designers using examples of current design research corporations.
Prerequisite(s): IDS 2016
Instructional Contact Hours: (3 Lec, 3 Crd)

IDS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

IDS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4015 - Industrial Design Laboratory IV (6 credits)
Detailed analysis, research and application of human factors to the design of equipment, work spaces and environments. Design and construction of full scale, interactive models and spaces. Introduction to group activities. Emphasis on the needs, the production and marketing factors of special populations, such as the elderly and disabled.
Prerequisite(s): IDS 3016
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 4016 - Industrial Design Laboratory IV (6 credits)
Detailed analysis, research and application of human factors to the design of equipment, work spaces and environments. Design and construction of full scale, interactive models and spaces. Introduction to group activities. Emphasis on the needs, the production and marketing factors of special populations, such as the elderly and disabled.
Prerequisite(s): IDS 4015
Instructional Contact Hours: (3 Lec, 9 Lab, 6 Crd)

IDS 4044 - Professional Practice and Entrepreneurship (2 credits)
Focus on assembling multidisciplinary teams to engage in the process of bringing a product to market, building a business around a core competency in design, the structure of a design office, and the development and protections of intellectual property. Pre-requisite: Senior standing or permission of instructor.
Prerequisite(s): IDS 2015
Instructional Contact Hours: (2 Lec, 2 Crd)

IDS 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGE 4094, MGT 4094

IDS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IDS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

IDS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Industrial Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
IDS 2015	Industrial Design Laboratory II	5
IDS 2016	Industrial Design Laboratory II	6
IDS 3015	Industrial Design Laboratory III	6
IDS 3016	Industrial Design Laboratory III	6
IDS 4015	Industrial Design Laboratory IV	6
IDS 4016	Industrial Design Laboratory IV	6
Subtotal		35
Major Requirements		
ARCH 1015	Foundation Design Laboratory	6
ARCH 1016	Foundation Design Laboratory	6
IDS 2034	Design Visualization	3
IDS 2044	Human Factors	3
IDS 2304	Computer Aided Industrial Design	3
IDS 3124	Materials and Processes	3
IDS 3514	Design Research	3
IDS 3900	Bridge Experience [1]	0
IDS 4044	Professional Practice and Entrepreneurship	2
Select six credits from the following:		6
IDS 3204	Topics in Professional Development [2]	
IDS 3224	Topics in Design Competencies [2]	
IDS 3234	Topics in Design Theory [2]	
Subtotal		35
Professional Elective Courses		
Complete 9 credit hours of 3XXX-4XXX Professional Electives [3]		9
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
ENGL 1106	First-Year Writing	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
ART 2385	Survey of the History of Western Art	3
ART 2386	Survey of the History of Western Art	3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6
MATH 1014 & MATH 1025	Precalculus with Transcendental Functions and Elementary Calculus	
MATH 1025 & MATH 1026	Elementary Calculus and Elementary Calculus	
MATH 1535 & MATH 1536	Geometry and Mathematics of Design and Geometry and Mathematics of Design	

Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
IDS 2114	History of Industrial Design	3
IDS 2124	History of Modern Industrial Designers	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**124**

Footnotes

1. The Bridge Experience is the application of academic knowledge and skills to a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre-Departmental approval of 3900 plan anytime after the first year. Register for the semester that corresponds with the beginning of the Bridge Experience.

2. Six credit hours from any of the Topics courses are required for completion of degree; two of the six credit hours must be used for these subtopics: Portfolio (1 credit) and Workshop (1 credit). The subtopic courses are short, however, the time and credit hours may vary depending on the subject. Subtopic offerings may be repeated with instructor's permission. The following are examples of subtopics offered:
IDS 3204 Topics in Professional Development | Portfolio; Service Learning (client/civic engagement); Public Speaking; Social Entrepreneurship
IDS 3224 Topics in Design Competencies | Software; Model Making; Workshop (wood, metal, plastics); Design Visualization; Packaging, Furniture, or Exhibit Design
IDS 3234 Topics in Design Theory | Product Semantics; Ethics; Sustainability; Universal Design; Cross-Cultural Design

3. Professional elective requirements can be fulfilled from various courses throughout campus. The following subjects at 3000 or 4000 level are approved as professional electives: IDS, ARCH, ITDS, LAR, ART, SOC, AHRM, PSYC, COMM, CS, ENGE, ENGL, HUM, DRS, MGT, MKTG, PHIL, RED, SBIO, STS. Enrollment is based on space available and prerequisites student has completed.

Satisfactory Progress Towards Degree

The University requires every department to establish benchmarks by which their majors can demonstrate that they are making satisfactory progress towards a degree. In addition to successful completion of the University requirements (See Satisfactory Progress in Academics chapter of the Undergraduate Catalog), in the case of Industrial Design, the student must have completed ARCH 1015 Foundation Design Laboratory and ARCH 1016 Foundation Design Laboratory with a minimum grade point average of 2.00. If a student receives below a "C-" in IDS 2015 Industrial Design Laboratory II, IDS 2016 Industrial Design Laboratory II, IDS 3015 Industrial Design Laboratory III, IDS 3016 Industrial Design Laboratory III, and IDS 4015 Industrial Design Laboratory IV, students will not be able to progress to the next semester of design laboratory and the course will need to be repeated.

Restricted Major Requirements

Students who apply to the Industrial Design major through the internal major change process must meet the following requirements prior to entering the major.

1. Minimum 2.5 gpa in all courses prior to entering the summer design lab
2. Apply for summer design lab; Interview for summer design lab
3. Faculty review of summer work and grade of "C-" or better in ARCH 1015 & ARCH 1016 for admission to the Industrial Design major

Graduation Requirements

GPA Requirements

If a student's in-major GPA drops below 2.30, IDS courses with a grade below 2.0 must be repeated to elevate the in-major GPA to 2.50 before continuing in the degree. In-major GPA is calculated on all IDS courses. A minimum in-major 2.30 GPA in IDS courses and a minimum overall 2.00 GPA is required for graduation.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Interior Design

Our Website (https://archdesign.caus.vt.edu/itds/)

Overview

The interior design program at Virginia Tech is dedicated to improving quality of life through design excellence, professionalism, and public service. With a curriculum that equally respects the importance of creative skill, history, building technology, ethics, innovation, and business practice, our graduates have the ability and confidence needed to immediately contribute to the profession.

Students in the interior program begin their studies in the foundation design laboratory during the first two semesters with architecture, landscape architecture and industrial design students. From the beginning, both an independent and team approach to design solutions is encouraged.

In their professional studies students are challenged to think critically in their design of space and to develop solutions that not only enhance quality of life, but also protect the health, safety, and welfare of users as prescribed in the various codes and regulations that govern the work of interior designers. This philosophy is the core of our program. It establishes a foundation upon which each student graduates with creative ingenuity and professional responsibility.

Our CIDA accredited program prepares future designers for licensure and practice. A degree from a CIDA accredited program is increasingly important as a requirement for professional certification and licensing of Interior Designers in the United States. Graduating from a CIDA accredited program is the first step in a three-part process in achieving certification or licensing as an interior designer in various states. The last two steps are to complete two years of assistantship as an interior designer and then passing the National Council for Interior Design Qualification (NCIDQ) examination. A CIDA accredited degree, work experience and passing the NCIDQ exam satisfy the requirements in Virginia for recognition as a "Certified Interior Designer."

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in Urban Affairs and Planning.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Interior Design Major (p. 599)

Chair: B. Whitney
Associate Professors: G. Tew[4,2], E. Tural, and B. Whitney
Assistant Professors: A. Tural, E. Elgewely, Y. Zhou
Associate Professor Emeritus: B. Parsons, H. Renard

Undergraduate Course Descriptions (ITDS)

ITDS 1114 - Design Appreciation (3 credits)
Introduction to fundamental design concepts, design methods and the history of design. Examples drawn from architecture, interior design, industrial design, graphic design as well as vernacular craft and design traditions. Key concepts from art, literature and philosophy are discussed in relation to design theory.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 1224 - Introduction to Interior Design (3 credits)
Introduction to the elements and principles of interior design, the discipline and practice of interior design. Case studies from interior design practice. Design thinking, language of design, career paths, contemporary issues, global issues, presentation and drawing techniques and sketchbook preparation.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 2044 - Interior Design I (6 credits)
First in a series of six studios. Foundation level interior design studio. Exploration and development of interior spaces emphasizing spatial volume, human factors, elements and principles of design, and presentation techniques. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ARCH 1016
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 2054 - Interior Design II (6 credits)
Spatial relationships continue as a priority from ITDS 2044 and become more advanced. Programs of required spaces are introduced in design projects along with issues of human behavior and perception and color. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 2044
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 2134 - Materials and Methods in Interior Design (3 credits)
Properties and appropriate use of materials in design and construction of building interiors. Floor, wall, and ceiling materials, and materials used in furnishings and equipment are included. Special attention is given to the health effects and environmental impact of material choices in interior design.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 2224 - Interior Design Graphic Communication (3 credits)
Exploration and development of advanced presentation techniques appropriate for communicating interior design concepts. Special attention is given to utilizing digital media as support for visual and verbal communication.
Prerequisite(s): ITDS 2114
Corequisite(s): ITDS 2144
Instructional Contact Hours: (6 Lab, 3 Crd)

ITDS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 3044 - Interior Design III (6 credits)
Exploration and development of interior spaces emphasizing corporate office use, branding of interior environments, and building system integration. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 2054
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 3054 - Interior Design IV (6 credits)
Design process, space planning and code compliance with advanced understanding of appropriate concepts for integrating furniture, fixtures, equipment, color, and finish materials in design solutions. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 3044
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 3114 - Sustainable Design and Biophilia (3 credits)
Sustainable design concepts and theories. Ethical considerations of biophilia, biomimicry, cradle-to-cradle, and other emerging ways of addressing environmental sustainability. Use of biophilia to guide decision making in the built environment. Use of core green building concepts including water use, energy use, sustainable sites and materials. Review of Green Building standards.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3125 - History of Interiors (3 credits)
Survey of significant developments in the design of interiors, furniture, and materials culture with a focus on western civilization. Style, scale, material culture of each period. Social, economic, technological and political influences on design. Significant designers and craftsmen. 3125: 3000 BC through the 19th century European. Egypt, Greece, Rome, Renaissance, Baroque, Rococo, Neoclassical. 3126: Colonial America through 21st century including Modern design. Bauhaus, DeStijl, Post-War, Post-Modern, Eastern influences.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3126 - History of Interiors (3 credits)
Survey of significant developments in the design of interiors, furniture, and materials culture with a focus on western civilization. Style, scale, material culture of each period. Social, economic, technological and political influences on design. Significant designers and craftsmen. 3125: 3000 BC through the 19th century European. Egypt, Greece, Rome, Renaissance, Baroque, Rococo, Neoclassical. 3126: Colonial America through 21st century including Modern design. Bauhaus, DeStijl, Post-war, Post-Modern, Eastern influences.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3175 - Building Systems for Interior Design (3 credits)
Overview of building systems as they relate to the design of building interiors. 3175: overview of building construction including structural systems and materials, code information and thermal concepts related to building systems. 3176: lighting for buildings, sustainable design guidelines, integration of building systems.
Prerequisite(s): ITDS 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3176 - Building Systems for Interior Design (3 credits)
Overview of building systems as they relate to the design of building interiors. 3175: overview of building construction including structural systems and materials, code information and thermal concepts related to building systems. 3176: lighting for buildings, sustainable design guidelines, integration of building systems.
Prerequisite(s): ITDS 2044 and ITDS 3175
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3184 - Construction Documents for Interior Design (3 credits)
An overview of construction documents: drawings and specifications. Development of a set of construction documents for a small commercial interior.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 3954 - Study Abroad-Interior Design (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4044 - Interior Design V (6 credits)
High-level spatial quality and design solution. Exploration and development of interior spaces for a variety of project types. Focus on collaboration and team work. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 3054
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 4054 - Interior Design VI (6 credits)
Senior Thesis studio requiring the integration of research and the design of a self-generated project. Course contact to credit hour structure: Lecture (1H,1C), Lab (6L, 2C), Design Lab/Studio (5L,3C).
Prerequisite(s): ITDS 4044 and ITDS 4224
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

ITDS 4224 - Design Research for Interiors (3 credits)
Project Programming and Design Research Methods in Interior Design. Evaluate and apply design research. Methods in design research, evidence-based design, and neuroscience.
Corequisite(s): ITDS 4044
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 4554 - Contemporary Interior Design Practice (3 credits)
Study of social, economic, political, and technological issues that influence contemporary interior design practice.
Prerequisite(s): ITDS 3126
Instructional Contact Hours: (3 Lec, 3 Crd)

ITDS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITDS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Interior Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ITDS 2044	Interior Design I	6
ITDS 2054	Interior Design II	6
ITDS 2134	Materials and Methods in Interior Design	3
ITDS 3044	Interior Design III	6
ITDS 3054	Interior Design IV	6
ITDS 3125	History of Interiors	3
ITDS 3126	History of Interiors	3
ITDS 3175	Building Systems for Interior Design	3
ITDS 3176	Building Systems for Interior Design	3
ITDS 3184	Construction Documents for Interior Design	3
ITDS 4044	Interior Design V	6
ITDS 4054	Interior Design VI	6
ITDS 4224	Design Research for Interiors	3
ITDS 4554	Contemporary Interior Design Practice	3
Subtotal		60
Professional Elective Courses		
ARCH 1015	Foundation Design Laboratory (required)	6
ARCH 1016	Foundation Design Laboratory (required)	6
Select one of the following:		3
ITDS 3114	Sustainable Design and Biophilia	
ITDS 3954	Study Abroad-Interior Design	
ITDS 4964	Field Study	
ITDS/ARCH/IDS/LAR/ART 2XXX-4XXX [1]		
Subtotal		15
Free Electives		
Select remaining credits of free electives		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		

ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
ART 2385	Survey of the History of Western Art	3
or ART 2386	Survey of the History of Western Art	
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
SOC 1004	Introductory Sociology	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Choose one of the following sequences of foundational math courses:		*6*
MATH 1014 & MATH 1025	Precalculus with Transcendental Functions and Elementary Calculus	
Or		
MATH 1025 & MATH 1026	Elementary Calculus and Elementary Calculus	
Or		
MATH 1535 & MATH 1536	Geometry and Mathematics of Design and Geometry and Mathematics of Design	
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
ITDS 1224	Introduction to Interior Design	3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Satisfied by completion of SOC 1004. If double counting 3 additional credit hours of electives will be required.		
Subtotal		42
Total Credits		**120**

[1] Students can choose any course at the 2000 level or above in ITDS, ARCH, IDS, LAR, or ART with permission of the Interior Design Program Chair.

Satisfactory Progress

- Students must maintain a 2.0 minimum GPA (in all courses taken at Virginia Tech) to continue in the program.
- Students must maintain an overall 2.5 minimum in all in major courses. (This includes all courses with an ITDS pre-fix, and ARCH 1015 Foundation Design Laboratory-ARCH 1016 Foundation Design Laboratory). If a student's GPA drops below a 2.5 in ITDS courses, courses with below a 2.5 must be repeated to elevate the GPA to 2.5 before continuing in the degree. A grade of "C-" or better is required in ITDS 2044 Interior Design I, ITDS 2054 Interior Design II, ITDS 3044 Interior Design III,ITDS 3054 Interior Design IV, ITDS 4044 Interior Design V, and ITDS 4054 Interior Design VI.

Graduation Requirements

GPA

- Students must maintain a 2.0 minimum GPA (in all courses taken at Virginia Tech) to continue in the program.
- Students must maintain an overall 2.5 minimum in all in major courses. (This includes all courses with an ITDS pre-fix, and ARCH 1015-ARCH 1016). If a student's GPA drops below a 2.5 in ITDS courses, courses with below a 2.5 must be repeated to elevate the GPA to 2.5 before continuing in the degree. A grade of "C-" or better is required in ITDS 2044 Interior Design I, ITDS 2054 Interior Design II, ITDS 3044 Interior Design III, ITDS 3054 Interior Design IV, ITDS 4044 Interior Design V, and ITDS 4054 Interior Design VI.

Prerequisite Statement

Some courses as part of this degree may have pre- or co- requisite requirements; please consult the university course catalog or check with your academic advisor.

Foreign Language Requirement

Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Landscape Architecture

Our Website (http://www.lar.vt.edu)

Overview

Landscape Architecture encompasses the design, analysis, planning, management, and stewardship of sustainable environments. Landscape architects design across a wide spectrum of projects: parks and gardens, community design, urban design and planning, green infrastructure, and regional planning, as well as at the scale of watersheds and natural systems. The work of the profession is grounded in the natural and social sciences, draws inspiration from nature and the arts, and is implemented through innovative design, site engineering, construction, land management, and environmental technologies. The Landscape Architecture Program guides students as they address some of the most important challenges of our time: climate change; healthy living and empathetic design; urbanization; just and livable cities; re-imagining water, food, energy and transportation systems; green infrastructure; remediation of spoiled and disturbed sites; and preservation and conservation of critical natural and cultural resources. We believe the work of landscape architecture is at the critical intersection of natural and cultural systems, and that the profession is the most consequential of the design arts in the 21st century.

The core of the academic program is a rigorous sequence of design studios that allows students to explore a broad range of landscape architectural issues, contexts, and project types. Studios are accompanied by discussion, lecture, and laboratory courses that provide systematic and comprehensive coverage of the emerging body of knowledge related to technology, design theory, landscape ecology, and human/environment interaction. Off-campus options include a summer

travel studio, a semester study at other academic institutions, as well as an independent studies and professional internships.

The Bachelor of Landscape Architecture (B.L.A.) is a four-year first-professional degree program fully accredited by the Landscape Architecture Accreditation Board. Graduates have a wide range of employment and professional opportunities including work in private practice, multidisciplinary firms, public agencies and municipalities, non-governmental organizations and non-profits.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in Landscape Architecture. Landscape Architecture majors must attain a C- or better in their studio and technology courses to advance to the next courses in these sequences.

Satisfactory progress requirements toward the degree can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Landscape Architecture Major (p. 604)

Program Chair: Terry Clements[2]
Professors: T. Clements and M. Kim
Associate Professors: C. L. Bohannon and N. Heavers,
Professor Emeritus: D. Bork, B. Johnson, and P. Miller

Undergraduate Course Descriptions (LAR)

LAR 1014 - Landscape Architecture Foundation Design Laboratory (6 credits)
Immersive, interactive learning environment, design concept and process development, self and peer assessment. Design studies in two and three dimensions across multiple scales, landscape systems, foundational design theories, principles of spatial design and techniques used to create landscape spaces, systematical exploration and communication of ideas through visual, physical, and oral communications.
Prerequisite(s): ARCH 1015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 1254 - Environment and Natural Systems (3 credits)
Introduction to the environment, natural systems with emphasis on their relationship to urban sustainability and resilience: natural elements, structures, patterns, natural systems, ecology, and landscape ecology. Impact of human actions and decisions on the environment and natural systems from global to local scale. Application of relevant theories and methods related to the environment and natural systems in planning and design.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 1264 - Seeing, Understanding and Representing Landscape and the Built Environment (3 credits)
Exploration of the natural and built environment through observation, interpretation and graphic representation of the landscape. Development of a range of graphic strategies and techniques with an emphasis on design thinking, iteration, and ethical issues expressed in the natural and built environment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2015 - Landscape Architecture Design Studio: Place and Process (6 credits)
Basic theory, principles, and methods of landscape design and site planning. 2015: Design theory involving two and three dimensional compositions. Mass/space relationships, principles of spatial design and techniques used to create landscape space. 2016: Design theory relating to landscape design and site planning. Design of small scale spaces in which the analysis of site, context and the requirements of human use are brought together in a creative synthesis.
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2016 - Landscape Architecture Design Studio: Place and Process (6 credits)
Basic theory, principles, and methods of landscape design and site planning. 2015: Design theory involving two and three dimensional compositions. Mass/space relationships, principles of spatial design and techniques used to create landscape space. 2016: Design theory relating to landscape design and site planning. Design of small scale spaces in which the analysis of site, context and the requirements of human use are brought together in a creative synthesis.
Prerequisite(s): LAR 2015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2025 - Landscape Architecture Design Studio Place, Process and People (6 credits)
Landscape design and site planning including design processes, design communication, community-based design, case study methods, landscape performance. 2025: planning, programming and design of places, analysis of site, context and design for human use, and natural systems in creative design syntheses. 2026: master plan and site-scale planning and design incorporating multiple program elements with emphasis on social, cultural and natural systems infrastructure of neighborhoods and communities. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 1014
Corequisite(s): LAR 2164
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2026 - Landscape Architecture Design Studio Place, Process and People (6 credits)
Landscape design and site planning including design processes, design communication, community-based design, case study methods, landscape performance. 2025: planning, programming and design of places, analysis of site, context and design for human use, and natural systems in creative design syntheses. 2026: master plan and site-scale planning and design incorporating multiple program elements with emphasis on social, cultural and natural systems infrastructure of neighborhoods and communities. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 2025
Corequisite(s): LAR 3154
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 2154 - Landscape Architecture History (3 credits)
Historical development of designed landscapes and landscape architecture with emphasis on western and select non-western cultures. Thematic focus on design theories, the social constructions of nature and relationships with land, ideology of landscape, experience of landscape by different social groups and cultures, landscape ethics, and parallels between site and urban design.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2164 - Landform Function and Aesthetics (4 credits)
Design principles and technology related to the creation of landforms for functional, aesthetic, and environmental purposes. Landform grading techniques for integrating soils, water, vegetation, transportation systems, and structures through the design and construction processes. Evaluating landform performance for landscape resilience. Design Lab/ Studio.
Prerequisite(s): LAR 1264
Instructional Contact Hours: (1 Lec, 5 Lab, 4 Crd)

LAR 2254 - Social and Cultural Landscapes (3 credits)
Introduction to experiential and cultural content of designed landscapes. Physiological, functional, and psychological factors that affect experience of the landscape. Study of cultural values, attitudes, and philosophies that have shaped historic and contemporary landscapes.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 2554 - Leadership for Global Sustainability (3 credits)
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2554, NR 2554

LAR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 3015 - Intermediate Landscape Design and Construction Documents (6 credits)
Development of intermediate site planning and design knowledge skills. 3015 focuses on site/project scale planning and design with emphasis on greenfield development sites and models of conversation oriented design/development.
Prerequisite(s): LAR 2016
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 3016 - Intermediate Landscape Design and Construction Documents (6 credits)
3016 focuses on site/project scale planning and design involving multiple program elements with a focus on urban and suburban redevelopment and densification. Emphasis is given to the social, cultural and natural systems infrastructure of neighborhoods and communities.
Prerequisite(s): LAR 3015
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 3044 - Land Analysis and Site Planning (3 credits)
Concepts, principles, and processes of land analysis and evaluation for physical planning and design. Approaches to spatial problem solving with an emphasis on data collection, evaluation, and synthesis using applicable technologies such as Geographic Information Systems (GIS). Analysis and synthesis of natural and socio-cultural systems at varying scales in the site planning and design process using Geodesign method.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 3154 - Watershed Sensitive Site Design and Construction (4 credits)
Examines soil and water resource issues related to landscape architectural site planning and design. Key topics include watershed sensitive site design, estimation and management of storm water runoff, rainwater conservation, design of open channel conveyances for site planning applications, and erosion and sedimentation control. Prerequisite: LAR 2164 or consent of instructor
Prerequisite(s): LAR 2164
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

LAR 3164 - Design in Detail: Materials, Methods and Assembly (4 credits)
Landscape construction knowledge and practices integrating concepts of design detailing with material selection, sustainable construction methods, and environmental performance. Concepts of landscape performance in material use and human interaction, effects on the built environment, and technical documentation.
Prerequisite(s): LAR 2164
Instructional Contact Hours: (2 Lec, 3 Lab, 4 Crd)

LAR 3264 - People Community and Place (3 credits)
Advanced course focusing on landscape/behavior interactions and implications for the design of outdoor environments at site and community scales for sustainable communities. Systems approach to engage various community design program elements, including social, land use, physical infrastructure, public space, movement, energy, and natural systems, in place-making strategies for diverse populations. Methods of community participation and engagement used in community-based design practices. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4004 - History and Theory of Landscape Architecture II (3 credits)
This course studies theoretical and practical developments in landscape architecture and related arts through investigation and analysis of design theory and philosophy, and built form. Pre: 2004 or permission of instructor.
Prerequisite(s): LAR 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4014 - Design and Construction Documentation (6 credits)
Landscape architectural project-based design and construction documentation. Site design integrating experiential learning, programming, schematic design, design development, construction documentation, construction cost estimation, and technical specifications. Construction principles and practices in preparation of site design and set of construction documents. Community-based principles and practices for site design development. Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C) (1H, 11L, 6C).
Prerequisite(s): LAR 2164 and LAR 3154 and LAR 3164
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4034 - Evolution of the American Landscape (3 credits)
Examine and interpret physical changes in the rural and urban landscapes of the United States as they reflect cultural values; technologic innovations; immigration patterns; the roles of diverse professions over time; changing views of use, conversation and preservation of national resources; and expectations for places of live, work and play using an iterative writing process and reflective course discussions.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4084 - Landscape Design and Planning Studio (3-6 credits)
Advanced design studio addresses current land design and planning issues including global climate change across contexts and spatial scales using complex problem-solving methods of a geodesign framework. Domestic and international precedents, theories, guidelines, and regulations. Development and communication of consensus-based comprehensive plans and designs that address sustainability and resilience issues caused by climate change and others. Use of collaborative community-based design practices. Non-Majors - Lecture (1H, 1C), Lab (6L, 2C). Majors — Course Contact to Credit Hour Structure: Lecture (1H, 1C) Lab (6L, 2C) Design Lab/Studio (5L, 3C). Variable credit course. (1H, 6-11L, 3-6C)
Prerequisite(s): LAR 4014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 6-11 Lab, 3-6 Crd)

LAR 4094 - Senior Project (3-6 credits)
Advanced landscape architectural design capstone course using applied research requiring development of a landscape architecture project selected and completed by the student under the direction of a faculty advisor. Landscape architecture theories and issues; design principles and processes, technological tools and communication strategies to develop and implement a comprehensive design study or independent design project in the context of specific concerns of the built environment. Repeatable for a maximum of 9 credit hours. 3 credit hour course - Lecture (1H, 1C), Lab (6L, 2C). 6 credit hour course - Course Contact to Credit Hour Structure: Lecture (1H, 1C), Lab (6L, 2C), Design Lab/Studio (5L, 3C). Variable credit course. (1H, 6-11L, 3-6C)
Prerequisite(s): LAR 4014 and LAR 4084
Instructional Contact Hours: (1 Lec, 6-11 Lab, 3-6 Crd)
Repeatability: up to 9 credit hours

LAR 4134 - Landscape Representation (3 credits)
2D and 3D hand and digital drawing modes and representational techniques used in landscape design explorations and visual presentations. Study and application of landscape representations. Visual communication of landscapes, landscape change, hydrologic patterns, ecologic processes, and human systems related to design, planning and management of the built environment across geographic and site scales. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

LAR 4154 - Design Studies of the Built Environment (3-6 credits)
Design study of built environment using comparative case studies of relationships between society and culture and the physical and built environments, as seen across scales. Design and use analysis and documentation of elements of the physical environment; exploration of interface between building, people, and landscape systems. Independent case study research project includes on-site field investigations, design research and final documentation of findings. Pre: Junior standing. 3 credit hour course - Design Lab (5L, 3C). 6 credit hour course - Design Lab (9L, 6C) Variable credit. Design Lab/Studio. (5-9L, 3-6C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 5-9 Lab, 3-6 Crd)

LAR 4244 - Professional Practice in Landscape Architecture (3 credits)
Comparative study of career options, professional practice types in landscape architecture including current and future practices. Introduction to firm organizational structure, business models, organizational culture and project management. Review of laws, regulations, contracts, financial and business planning, professional ethics and societal forces impacting design processes and work from project inception to built outcomes. Portfolio and resume development.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4254 - Theories of Landscape Architecture (3 credits)
Critical examination of theories relevant to landscape architectural design and the inter-relationship between theory and practice. Evolution of theory with respect to built works. Overview of concurrent design theories and philosophies in the related arts. Pre-requisite: Senior standing or instructors permission.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAR 4304 - Topics in Landscape Architecture (3 credits)
Topics in landscape architecture history, theory and design methods is an advanced course focusing upon issues facing the professional practice of landscape architecture today. Special emphasis on methods of analysis and interpretation including application of creative techniques, analogous thinking, computer-aided procedures and information handling in landscape architecture design and practice. Pre: 3015 and 3016 or permission of instructor. May be repeated with different content for a maximum of 12 credits.
Prerequisite(s): LAR 3015 and LAR 3016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

LAR 4324 - Landscape Architecture Technology III-Construction Documents (4 credits)
This course provides the link between landscape architectural design and construction documentation. Landscape technology covered in preceding technology courses is combined with information on construction principles and practices in the preparation of landscape architectural construction drawings and technical specifications.
Prerequisite(s): LAR 4244
Instructional Contact Hours: (2 Lec, 4 Lab, 4 Crd)

LAR 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, HORT 4554, SPIA 4554

LAR 4705 - Landscape Design and Planning (6 credits)
Theories, methods, techniques, and tools relating to the planning and design of sites, communities, and regional landscapes. 4705: Development of design ability through the study of: two- and three-dimensional design, principles and elements of spatial composition, theories and techniques for planning and design of sites, and design communication techniques. Investigation of natural and man-made physical factors and cultural factors, and human needs. Creative design synthesis. 4706: Evaluation of land resources and the allocation of land uses within large complex sites and regional landscapes. Theories and techniques of site planning and community design. Research of natural, cultural and physical conditions. Application of geographic information systems. Assessment of community development and land planning concepts. Proposing land-use and management strategies at community and regional landscape scales. Identification and application of community-based design practices. Pre: 4705 for 4706. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4706 - Landscape Design and Planning (6 credits)
Theories, methods, techniques, and tools relating to the planning and design of sites, communities, and regional landscapes. 4705: Development of design ability through the study of: two- and three-dimensional design, principles and elements of spatial composition, theories and techniques for planning and design of sites, and design communication techniques. Investigation of natural and man-made physical factors and cultural factors, and human needs. Creative design synthesis. 4706: Evaluation of land resources and the allocation of land uses within large complex sites and regional landscapes. Theories and techniques of site planning and community design. Research of natural, cultural and physical conditions. Application of geographic information systems. Assessment of community development and land planning concepts. Proposing land-use and management strategies at community and regional landscape scales. Identification and application of community-based design practices. Pre: 4705 for 4706. Course Contact to Credit Hour Structure: Lecture (1H,1C), Lab (6L, 2C) Design Lab/Studio (5L, 3C). (1H, 11L, 6C)
Prerequisite(s): LAR 4705
Instructional Contact Hours: (1 Lec, 11 Lab, 6 Crd)

LAR 4964 - Field Work (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Landscape Architecture Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
LAR 1014	Landscape Architecture Foundation Design Laboratory	6
LAR 2025	Landscape Architecture Design Studio Place, Process and People	6
LAR 2026	Landscape Architecture Design Studio Place, Process and People	6
LAR 4014	Design and Construction Documentation	6
LAR 4084	Landscape Design and Planning Studio	6
LAR 4094	Senior Project	3
LAR 4094	Senior Project	6
Subtotal		39
Major Requirements		
ARCH 1015	Foundation Design Laboratory	6
LAR 1254	Environment and Natural Systems	3
LAR 1264	Seeing, Understanding and Representing Landscape and the Built Environment	3
LAR 2154	Landscape Architecture History	3
LAR 2164	Landform Function and Aesthetics	4
LAR 3044	Land Analysis and Site Planning	3
LAR 3154	Watershed Sensitive Site Design and Construction	4
LAR 3164	Design in Detail: Materials, Methods and Assembly	4
LAR 3264	People Community and Place	3
LAR 4034	Evolution of the American Landscape	3
LAR 4154	Design Studies of the Built Environment	6
LAR 4244	Professional Practice in Landscape Architecture	3
LAR 4254	Theories of Landscape Architecture	3
Subtotal		48
Restricted Electives		**6**
Earth Science Elective		
Select one of the following:		
GEOS/CSES/ GEOG 3304	Geomorphology	
ENSC 3134	Soils in the Landscape	
FREC 4354	Forest Soil and Watershed Management	
CSES 3114	Soils	
Plant Science Electives		
Select one of the following:		
HORT 3325	Woody Landscape Plants	
HORT 3326	Woody Landscape Plants	
FREC 2314 & FREC 2324	Forest Biology and Dendrology and Dendrology Laboratory	
Subtotal		6
Pathways to General Education		

Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
LAR 4034	Evolution of the American Landscape (1A (Major Req. Course)) [1]	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
LAR 3264	People Community and Place (Major Req. Course)	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
GEOS 1004	Earth Science: Our Past, Present, and Future	3
LAR 1254	Environment and Natural Systems (Major Req. Course)	3
Pathways Concept 5 - Quantitative and Computational Thinking		*3*
Select two of the following:		
MATH 1014	Precalculus with Transcendental Functions	
or MATH 1536	Geometry and Mathematics of Design	
MATH 1025	Elementary Calculus	
or MATH 1536	Geometry and Mathematics of Design	
LAR 3044	Land Analysis and Site Planning (5A (Major Req. Course))	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
LAR 1264	Seeing, Understanding and Representing Landscape and the Built Environment (Major Req. Course)	
LAR 2154	Landscape Architecture History (Major Req. Course)	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select from any approved Ident & Equity Course [2]		3
Total Credits		**120**

[1] LAR 4034 Evolution of the American Landscape can count as either Pathways 1a or 2.

[2] May be double-counted with another Pathways approved core concept course.

Prerequisites

Some courses listed on this checksheet may have prerequisites and/or corequisites; please consult the University Course Catalog or check with your advisor.

Restricted Major Requirements

Students who make application to Landscape Architecture through the change of major process must meet the following requirements prior to entering the major.

1. Minimum 2.0 overall GPA prior to ARCH 1015, and
2. Application Interview with Landscape Architecture Program Chair.

Graduation GPA Requirement

In-major GPA and an overall GPA: A 2.0 GPA is required for graduation.

Policy 91 Requirements

Satisfactory progress toward degree: In addition to successful completion of the University requirements, all students must achieve a minimum 2.0 GPA by the end of the semester in which the 50th credit hour is attempted. All students must receive a C- or higher in all Core Degree Required Courses and technology courses (LAR 2164 Landform Function and Aesthetics, LAR 3154 Watershed Sensitive Site Design and Construction, LAR 3164 Design in Detail: Materials, Methods and Assembly and LAR 3044 Land Analysis and Site Planning).

Foreign Language Requirement

Complete 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent.

Music

Our Website (http://www.performingarts.vt.edu)

Overview

The Virginia Tech Music program provides high-quality training to a select number of Music majors as well as ensembles and courses for large numbers of non-music majors. The curriculum offers an excellent liberal arts education with a low professor/student ratio combined with the library, computer facilities, and cultural interaction that only a major comprehensive university can provide. Learning is enhanced by the use of music technology across the curriculum and innovative programs such as laboratory ensembles and extensive teaching experiences in the Music Education program. Together with traditional degree programs in Performance, Music Education, Technology, Composition, and Creative Technologies.

Virginia Tech faculty artists and scholars have performed and lectured at conventions, in music festivals, and on concert series throughout the United States and in Canada, Europe, Asia, and South America. Each year, internationally known guest artists join forces with our faculty to perform world caliber performances on campus.

Prospective Music majors must successfully complete an audition/interview. To receive information concerning auditions and scholarship opportunities, contact the chairperson:

Music Scholarship and Audition Committee
School of Performing Arts
195 Alumni Mall (0141)
Henderson Hall, Room 247
Blacksburg, Virginia 24061-0240

Scholarship support is available. Please also refer to the School of Performing Arts website for more details.

The major in Music, leading to a B.A., emphasizes four areas of music: music education; performance; technology and composition. In addition to fulfilling the Curriculum for Liberal Education and the core curriculum requirements of the College of Architecture, Arts, and Design, the Music major must pursue a concentration in one of the above areas of emphasis. There are nine primary options available to Music majors. These are:

- 84-Credit Music Education Option (see website for details)
- 51-Credit Performance - Liberal Arts Option
- 78-Credit Performance - Professional Vocal Option

- 78-Credit Performance - Professional Instrumental Option
- 78-Credit Composition - Professional Option
- 54-Credit Creative Technologies in Music Option
- 52-Credit Music Technology - Liberal Arts Option
- 78-Credit Music Technology - Professional Option

In addition, all Music majors must meet a minimum level of piano proficiency no later than two semesters prior to graduation. Music majors are expected to attend a minimum number of concerts and recitals. Additional curriculum and policy information is available in the Handbook for Music Majors on the School of Performing Arts website.

There are four options available as a minor in Music, including a general Music minor, a Music Production, Technology, and Composition minor, a Music (Technology Emphasis) minor, and a Music (Jazz Studies) minor. The minor in music consists of courses selected from performance, history/literature, and theory/composition. For the exact requirements, interested students should contact:

Tammy Henderson
Virginia Tech
246 Henderson Hall
Blacksburg, Virginia 24061-0240
tammyh@vt.edu

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in music.

Satisfactory progress requirements toward the B.A. in Music can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Music Major with Composition Option (p. 614)
- Music Major with Creative Technologies in Music Option (p. 616)
- Music Major with Music Education Choral/General Option (p. 618)
- Music Major with Music Education Instrumental Option (p. 619)
- Music Major with Performance Liberal Arts Option (p. 621)
- Music Major with Performance Professional Instrumental Option (p. 623)
- Music Major with Performance Professional Vocal Option (p. 625)
- Music Major with Technology Liberal Arts Option (p. 626)
- Music Major with Technology Professional Option (p. 628)

Director, School of Performing Arts | Music | Theatre | Cinema: J. Loeffert

Chair: J. Crafton
Professors: D. Bigler, I.I. Bukvic, W. J. Crone, and J. Loeffert
Associate Professors: J. Crafton, C. Nichols, A. Stevens, B. Thorsett, A. Weinstein, A. Wyatt, and H. Yoo
Assistant Professors: C. Campo-Bowen, , M. Elmer, J. Irrera, K. Loeffert, E. McLain, E. O'Leary, R.J. Masters, and D. Shapiro
Collegiate Assistant Professors: M. Wilkens-Reed

Professor of Practice: E. Lyon

Assistant Professors of Practice: A. Cowan, K. Hutchins, and P. Middleton

Senior Instructors: E. Lantz, M. E. Dunston

Instructors: J. Bean, J. Berrios, C. Pace, and C. Reep
Visiting Assistant Professors: B. Newcomer

Visiting Instructors: D. Gonzalez

A/P Faculty: A. Bank
Professors Emeritus: V. Burnsed, K. Holliday, J. Husser, D. Jacobsen, and D. Widder
Academic Advisor: D. Hopkins

Undergraduate Course Descriptions (MUS)

MUS 1004 - School of Performing Arts First Year Experience (1 credit)
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the Schools programs. Foster a sense of community and understanding across disciplines.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: TA 1004

MUS 1005 - Theory Fundamentals (3 credits)
Fundamental elements of music theory. 1005: Introduction to elements of music theory. Musical notation, scales of various global traditions, foundations of tonality; intervals, triads, dominant seventh chords, rhythm, meter, cadences, harmonic analysis. Composition with species counterpoint and the twelve-bar blues progression. Aural recognition of musical sounds through ear training. 1006: More complex harmonic and rhythmic processes. Increase complexity of intervals, chords, rhythms, progressions and score reading. Introduce transposition and vocabulary for timbre and textural discussion. Aural recognition of more advanced musical sounds through ear training. Fluency in terms and conventions for western art music, rock, hip-hop. Composition of original music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1006 - Theory Fundamentals (3 credits)
Fundamental elements of music theory. 1005: Introduction to elements of music theory. Musical notation, scales of various global traditions, foundations of tonality; intervals, triads, dominant seventh chords, rhythm, meter, cadences, harmonic analysis. Composition with species counterpoint and the twelve-bar blues progression. Aural recognition of musical sounds through ear training. 1006: More complex harmonic and rhythmic processes. Increase complexity of intervals, chords, rhythms, progressions and score reading. Introduce transposition and vocabulary for timbre and textural discussion. Aural recognition of more advanced musical sounds through ear training. Fluency in terms and conventions for western art music, rock, hip-hop. Composition of original music.
Prerequisite(s): MUS 1005
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1104 - Music Appreciation (3 credits)
Survey of the art of music encompassing a variety of music styles and historical eras in both the western and non- western world. Students will develop strategies to contextualize music, via listening, from the perspective of the listener, composer, and performer.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1114 - Listening in the Digital Age (3 credits)
An introduction to musical access and listening in the digital age. Introduces basic elements of music and the creative process together with important musicians and their works. Explores historical, social, and cultural forces and trends that influence the creation and interpretation of various musical styles, including classical, blues, jazz, popular, and world music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1124 - Living a Musical Life (3 credits)
Embrace a wide variety of music and ways to make music. Learn about the health benefits of lifelong music-making. Units include regional, national, and international traditions in historical, political, and cultural contexts. No prior musical training required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 1134 - Music of the Americas (3 credits)
Musical traditions in the American continent, with a specific focus on Latin-American and Latinx musics. Introduction to music from different traditions across nations and social-historical contexts. Critical engagement with broad social concepts from cultural, political, and historical perspectives. Development of listening and writing skills.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2025 - European-American Music Theory (3 credits)
Fundamental elements of music and conventions of genre and style in a global context. 2025: pitch & harmony, rhythm & meter, timbre, texture, and movement. Emphasis on rote learning of pitch notation, intervals, key signatures, chords vs non-chord tones, and pitch collections. Methods to analyze harmony, phrase structure, and meter. Develop vocabulary for timbre and texture. Basic skills of score reading and transposition. 2026: form, as well as more complex harmonic and rhythmic processes, such as harmonic rhythm, syntax and metric dissonance. Increase complexity of score reading to include larger ensembles. In-depth study of genre, considering elements of harmony, rhythm & meter, and form in European and North-American classical, jazz, and popular musics.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2026 - European-American Music Theory (3 credits)
Fundamental elements of music and conventions of genre and style in a global context. 2025: pitch & harmony, rhythm & meter, timbre, texture, and movement. Emphasis on rote learning of pitch notation, intervals, key signatures, chords vs non-chord tones, and pitch collections. Methods to analyze harmony, phrase structure, and meter. Develop vocabulary for timbre and texture. Basic skills of score reading and transposition. 2026: form, as well as more complex harmonic and rhythmic processes, such as harmonic rhythm, syntax and metric dissonance. Increase complexity of score reading to include larger ensembles. In-depth study of genre, considering elements of harmony, rhythm & meter, and form in European and North-American classical, jazz, and popular musics.
Prerequisite(s): MUS 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2045 - Sightsinging Laboratory (1 credit)
Study and practice of techniques involved in the sight reading and sightsinging of printed music. Majors and minors only.
Corequisite(s): MUS 2025
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2046 - Sightsinging Laboratory (1 credit)
Study and practice of techniques involved in the sight reading and sightsinging of printed music. Majors and minors only.
Prerequisite(s): MUS 2045
Corequisite(s): MUS 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2054 - Introduction to Music Technology (2 credits)
History, theory, and applications of music technology. Techniques for notating music and for recording and editing audio, using computer software and digital audio equipment. Consent Required. Design lab.
Instructional Contact Hours: (3 Lab, 2 Crd)

MUS 2055 - Audio Technology For Music (3 credits)
Develops basic understanding of audio technology for musical applications, focusing on todays digital audio recording and editing technologies including microphone use, live recording, and studio session recording. Develops critical listening skills through lab experimentation and recording. Pre: 2054 and permission of instructor required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2056 - Audio Technology For Music (3 credits)
Develops basic understanding of audio technology for musical applications, focusing on todays digital audio recording and editing technologies including microphone use, live recording, and studio session recording. Develops critical listening skills through lab experimentation and recording. Pre: 2054 and permission of instructor required.
Prerequisite(s): MUS 2055
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2065 - Music Composition (2 credits)
Organizing the basic elements of music: pitch, rhythm, timbre, articulation, and dynamics. Composing pieces for solo instruments and duos. Preparing scores and parts, for performances and recordings of the compositions. Knowledge of basic music theory required. Consent Required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2066 - Music Composition (2 credits)
Composing for specific instruments and combinations of instruments. Exploring traditional and extended technique. Organizing the structure of a piece based on recurrence, development, variation, priority, and perspective of musical material, for trio adn quartet or a larger ensemble. A grade of C or better in prerequisite.
Prerequisite(s): MUS 2065
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2115 - Survey of Western Music (3 credits)
Survey and study of the historical evolution of Western art music. MUS 2115: classical music from Antiquity into the Classical era. MUS 2116: classical and other music from the Romantic era through the 20th century to music of today. Investigation of the materials of music. Exploration of music as it both reflects and impacts history, including historical considerations of gender, race, culture, and other extramusical factors. Relevance of historical and contemporary music to our society today.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2116 - Survey of Western Music (3 credits)
Survey and study of the historical evolution of Western art music. MUS 2115: classical music from Antiquity into the Classical era. MUS 2116: classical and other music from the Romantic era through the 20th century to music of today. Investigation of the materials of music. Exploration of music as it both reflects and impacts history, including historical considerations of gender, race, culture, and other extramusical factors. Relevance of historical and contemporary music to our society today.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2124 - Music Traditions in Appalachia (3 credits)
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 2124

MUS 2134 - Disability Culture & the Arts (3 credits)
Disability as an identity, community, and culture through a study of music and the arts. Overview of the disability rights and disability justice movements in the United States, as told through music, film, literature, and performance art. Analyze creative works, confront obstacles to inclusion, and discover disability cultural values. No previous musical training required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 2214 - Class Applied Piano (1 credit)
Group piano lessons for beginners or for students at an early stage of keyboard development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2224 - Class Applied Voice (1 credit)
Group voice lessons for beginners or for students at an early stage of vocal development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2234 - Class Applied Strings (1 credit)
Group string lessons for beginners or for students at an early stage of string development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2244 - Class Applied Woodwinds (1 credit)
Group woodwind lessons for beginners or for students at an early stage of woodwind development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2254 - Class Applied Brass (1 credit)
Group brass lessons for beginners or for students at an early stage of brass development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2264 - Class Applied Percussion (1 credit)
Group percussion lessons for beginners or for students at an early stage of development. May be repeated for 1 credit. Consent required.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 2 credit hours

MUS 2274 - Music Education Lab Ensemble (1 credit)
Music education laboratory ensemble. Performance techniques, teaching methods, management procedures, materials and literature for school music ensembles. May be repeated for credit.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2284 - Piano Accompanying (2 credits)
Examine and practice the skills necessary for successful piano accompanying. Develop keyboard skills such as sightreading, transposition, choral score reading, and harmonization. Learn principles of accompanying vocal repertoire, instrumental repertoire, including large ensemble repertoire; adapt orchestral reductions for piano. Instructor consent required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2314 - Woodwind Techniques I - Flute, Clarinet, Saxophone (1 credit)
Instruction in basic performing skills and practices for woodwind instruments (flute, clarinets, saxophone). Study of pedagogy for woodwind instruction in K-12 music education settings. Survey of repertoire, resources, and materials for use in woodwind instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2324 - Woodwind Techniques II - Oboe and Bassoon (1 credit)
Instruction in basic performing skills and practices for woodwind instruments (oboe, bassoon). Study of pedagogy for woodwind instruction in K-12 music education settings. Survey of repertoire, resources, and materials for use in woodwind instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2334 - High Brass Techniques (1 credit)
Instruction in basic performing skills and practices for high brass instruments (trumpet and horn). Study of pedagogy for teaching brass in K-12 music education settings. Survey of repertoire, resources, and materials for use in brass instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2344 - Low Brass Techniques (1 credit)
Instruction in basic performing skills and practices for low brass instruments (trombone, euphonium, and tuba). Study of pedagogy for teaching brass in K-12 music education settings. Survey of repertoire, resources, and materials for use in brass instruction.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 2364 - Introduction to Music Education (2 credits)
Principles and practices fundamental to music learning and teaching. Philosophical bases for teaching music. Major educational learning theories (e.g., behaviorism, cognitivism, social constructivism, multiple intelligences, spiral learning theory, Bloom's taxonomy, etc.). Pedagogical approaches, culturally responsive teaching, and technology integration in the music classroom. Field observation for real world public-school music instruction.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2514 - Individual Applied Voice (1-3 credits)
Individual instruction in voice. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2515 - Vocal Diction (1 credit)
An introduction to principles of vocal diction for singing using the International Phonetic Alphabet and standard foreign-language pronunciation techniques.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2516 - Vocal Diction (1 credit)
An introduction to principles of vocal diction for singing using the International Phonetic Alphabet and standard foreign-language pronunciation techniques.
Instructional Contact Hours: (1 Lab, 1 Crd)

MUS 2524 - Individual Applied Keyboard (1-3 credits)
Individual instruction in keyboard. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2534 - Individual Applied Violin (1-3 credits)
Individual instruction in violin. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2544 - Individual Applied Viola (1-3 credits)
Individual instruction in viola. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2554 - Individual Applied Cello (1-3 credits)
Individual instruction in cello. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2564 - Individual Applied Bass (1-3 credits)
Individual instruction in bass. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2574 - Individual Applied Flute (1-3 credits)
Individual instruction in flute. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2584 - Individual Applied Oboe (1-3 credits)
Individual instruction in oboe. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2594 - Individual Applied Clarinet (1-3 credits)
Individual instruction in clarinet. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2604 - Introduction to Arts Marketing (3 credits)
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field, and direct hands-on experience.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: TA 2604

MUS 2614 - Individual Applied Saxophone (1-3 credits)
Individual instruction in saxophone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2624 - Individual Applied Bassoon (1-3 credits)
Individual instruction in bassoon. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2634 - Individual Applied Horn (1-3 credits)
Individual instruction in horn. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2644 - Individual Applied Trumpet (1-3 credits)
Individual instruction in trumpet. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2654 - Individual Applied Trombone (1-3 credits)
Individual instruction in trombone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 2664 - Individual Applied Baritone (1-3 credits)
Individual instruction in baritone. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2674 - Individual Applied Tuba (1-3 credits)
Individual instruction in tuba. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2684 - Individual Applied Percussion (1-3 credits)
Individual instruction in percussion. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2734 - Individual Applied Composition (1-3 credits)
Individual instruction in composition. May be repeated. Consent and audition required.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 2754 - Individual Applied Recording (1-3 credits)
Individual instruction through directed experiential learning of music recording and production. Integration of critical listening, acoustics, audio recording, and signal processing with music theory and performance. An emphasis on hands-on exploratory research in the use of instruments, acoustics, and microphone techniques combined with traditional methods and emerging technologies to capture and produce recordings of musical performances and works in a natural and effective manner. Permission required. May be repeated for a maximum of 8 hours.
Prerequisite(s): MUS 2055
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 8 credit hours

MUS 2815 - Jazz Improvisation (2 credits)
Fundamental principles of jazz improvisation. Topics include interval relationships, chord identification, modes and modality, blues and ii-V-I chord progressions. Pre: Permission of instructor required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2816 - Jazz Improvisation (2 credits)
Fundamental principles of jazz improvisation. Topics include interval relationships, chord identification, modes and modality, blues and ii-V-I chord progressions. Pre: Permission of instructor required.
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 3024 - Counterpoint (3 credits)
Study of the development and aesthetics of contrapuntal techniques throughout the common practice period.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3025 - European-American Music Analysis (3 credits)
Extended compositional techniques in late-nineteenth and twentieth-century music, and analysis of larger works. 3025: chromatic harmony, twentieth-century techniques of pitch organization (e.g., set theory), grouping and displacement dissonance, large-scale musical forms. Analysis complemented by model composition and performance to demonstrate mastery of theoretical concepts and stylistic competency. 3026: synthesis of analytical techniques while navigating musical ambiguity in complete works of various sizes (miniatures to multi-part). Analytical observations connected to expressive or narrative meaning in musics from various styles and genres. Refine ability to write about music through research project.
Prerequisite(s): MUS 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3026 - European-American Music Analysis (3 credits)
Extended compositional techniques in late-nineteenth and twentieth-century music, and analysis of larger works. 3025: chromatic harmony, twentieth-century techniques of pitch organization (e.g., set theory), grouping and displacement dissonance, large-scale musical forms. Analysis complemented by model composition and performance to demonstrate mastery of theoretical concepts and stylistic competency. 3026: synthesis of analytical techniques while navigating musical ambiguity in complete works of various sizes (miniatures to multi-part). Analytical observations connected to expressive or narrative meaning in musics from various styles and genres. Refine ability to write about music through research project.
Prerequisite(s): MUS 3025
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3034 - Form and Analysis in the Common-practice Period (3 credits)
Domains of rhythm and meter, harmony, and cadence as related to musical form. Score-based and aural analysis of formal functions of common theme-types and large-scale forms in selected works from the mid-eighteenth through nineteenth centuries using William Caplin's theory. Identification of deviations from stylistic norms. Analysis complemented by model composition to demonstrate mastery of theoretical concepts and stylistic competency.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3035 - Advanced Class Piano (1 credit)
Develop keyboard skills such as sightreading, harmonization, transposition, learn all scales/arpeggios and important keyboard progressions. A grade of C or better required in prerequisite.
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3036 - Advanced Class Piano (1 credit)
Continued development of keyboard skills. Advanced transposition, harmonization, and sightreading, open score reading, and real-world application of skills acquired throughout keyboard study. A grade of C or better required in prerequisite.
Prerequisite(s): MUS 3035
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3044 - Orchestration & Analysis (3 credits)
An introduction to the craft of scoring and arranging of music for full orchestra. Analysis of scores, small projects and a full orchestration project.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3045 - Advanced Ear Training (1 credit)
3045: Hearing chromatic chord function in melodic and harmonic contexts. Sight-singing chromatic melodies and performing chromatic progressions. Aurally recognizing musical form (binary, ternary, strophic). Discovering markedness in common practice era music and recognizing commonalities with and differences from other music cultures A grade of C or better required in prerequisite. 3046: Hearing chord function in advanced chromatic melodic and harmonic contexts. Sight-singing advanced chromatic melodies and performing highly chromatic progressions. Aurally recognizing musical form (sonata, rondo, other forms). Hypothesizing about evolution of style and articulating intertextual experience. A grade of C or better required in prerequisite.
Prerequisite(s): MUS 2046 and MUS 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3046 - Advanced Ear Training (1 credit)
Prerequisite(s): MUS 3045
Instructional Contact Hours: (3 Lab, 1 Crd)

MUS 3054 - Introduction to Vocal/choral Arranging (3 credits)
Techniques of arranging music for vocal/choral ensembles. Emphasis on transcription from recordings to develop rhythmic, melodic, and harmonic dictation skills. Discussion, transcription, listening, small writing exercises, final project.
Prerequisite(s): MUS 3035 and MUS 3036
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3055 - Music and Media Production (3 credits)
Develops advanced knowledge of music production through practical application of music recording and production technologies, including advanced microphone techniques, critical listening, and critical artistic evaluation skills. Individual and group production projects. Hands-on experience with a variety of expressive media technologies including CD and DVD production in a collaborative, inter- disciplinary team approach.
Prerequisite(s): MUS 2056
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3056 - Music and Media Production (3 credits)
Develops advanced knowledge of music production through practical application of music recording and production technologies, including advanced microphone techniques, critical listening, and critical artistic evaluation skills. Individual and group production projects. Hands-on experience with a variety if expressive media technologies including CD and DVD production in a collaborative, interdisciplinary team approach.
Prerequisite(s): MUS 3055
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3064 - Digital Sound Manipulation (3 credits)
Cross-disciplinary study of recording technology and its effects on music. Aesthetics of electronic music. Recording and editing digital sound. Visual programming for live sound synthesis and processing. Acoustic compilers for programmatic sound processing and synthesis. Individual creative applications of tools learned in class. Team-based work on creative projects. Emphasis on intercultural and global use of creative music technologies.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3065 - Computer Music and Multimedia Design (3 credits)
A two-semester study of interactive multimedia composition and performance software as a foundation for creative work and research endeavors. Also provides an in-depth study of digital sound synthesis, algorithmic creation of multimedia content, and the design of audio-visual interactive systems using latest technologies. Must meet pre-requisite or have permission of the instructor
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3066 - Computer Music and Multimedia Design (3 credits)
A two-semester study of interactive multimedia composition and performance software as a foundation for creative work and research endeavors. Also provides an in-depth study of digital sound synthesis, algorithmic creation of multimedia content, and the design of audio-visual interactive systems using latest technologies. Must meet pre-requisite or have permission of the instructor
Prerequisite(s): MUS 3065
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3074 - Topics in Music Analysis (3 credits)
Contemporary methods of music analysis. Readings from landmark music theory texts and top music theory journals. Analysis of complementary music. Formulating unique research projects to demonstrate mastery of theoretical frameworks. May be repeated 2 times with different content for a maximum of 9 credit hours.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MUS 3114 - Symphonic Literature (3 credits)
Study of representative works of symphonic music from the eighteenth, nineteenth, and twentieth centuries, with corollary readings in the history of musical ideas. Consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3124 - 20th Century Music Literature (3 credits)
An introduction to music in Europe and America since 1945; supplementary study in the aesthetics of contemporary music. Consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3134 - Vocal Music Literature (3 credits)
Covers vocal music of Europe and America, especially music composed the eighteenth century. Examines differences in style and forms of choral and solo-vocal expression characteristic of the Baroque, Classic, Romantic, and Modern eras. Discusses issues of vocal performance practice. Ability to read music required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3144 - Early Music Literature (3 credits)
Covers vocal and instrumental music from the Middle Ages to the eighteenth century. Examines differences in style and forms of expression characteristic especially of Medieval, Renaissance, and early Baroque music. Discusses issues of performance practice. Ability to read music required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3154 - Piano Literature (3 credits)
Study of representative works of keyboard repertoire from the 17th century to the works of contemporary composers. Extensive stylistic analysis and discussion of performance practice. Pre: consent required.
Prerequisite(s): MUS 3026 and MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3164 - History of Electronic Music (3 credits)
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3164H - History of Electronic Music (3 credits)
Seminal electronic music works in historical context. Electronic music practices of the 20th and 21st centuries. The technologies of electronic music. Analysis of electronic music. Historical origins and trends in electronic music. Connections between experimental and popular electronic music forms.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3174 - Music as Global Culture (3 credits)
Musical traditions from around the globe as both artistic production and cultural practice. Expose students to music from both non-Western and Western traditions. Connect cultural context to musical meaning. Critical engagement with different musics and their histories.
Prerequisite(s): MUS 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3184 - Histories of Music I: Music in the European and American Traditions (3 credits)
Examination of the development of different musical genres in Europe and the Americas from approximately 1600 to 1918. Consideration of historical and sociocultural context. Introduction of a diverse array of styles and genres. Critical engagement with social, cultural, and historical issues and their relation to music. Development of historical research skills, facility with writing about music, and practical applications.
Prerequisite(s): MUS 3174
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3194 - Histories of Music II: Music in the 20th and 21st Centuries (3 credits)
Musical traditions and developments in the twentieth and twenty-first centuries, with emphasis on music (voice, acoustic, and electronic) in the United States and increasing globalization. Introduction of students to music from both non-Western and Western traditions. Critical engagement with formalized and vernacular musics through sociopolitical concepts (race, gender, etc.). Research into music in the twenty-first century United States. Development of both historical and ethnographic research skills. Writing about music.
Prerequisite(s): MUS 3174
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3214 - Teaching Music in the Elementary School (3 credits)
Methods of teaching elementary school music. Emphasis on Kodaly, Orff, and traditional music textbook series approaches to teaching music in elementary schools. Pre: Instructor permission and successful completion of sophomore music continuation exam.
Corequisite(s): MUS 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3225 - Conducting (3 credits)
An introduction to the practice and theory of ensemble conducting and leadership. 3225: Basic conducting skills, and choral conducting. 3226: Intermediate conducting skills, and instrumental conducting. Consent required.
Prerequisite(s): MUS 3026
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3226 - Conducting (3 credits)
An introduction to the practice and theory of ensemble conducting and leadership. 3225: Basic conducting skills, and choral conducting. 3226: Intermediate conducting skills, and instrumental conducting. Consent required.
Prerequisite(s): MUS 3225
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3234 - Piano Pedagogy (3 credits)
Examination of principles and practice of piano pedagogy. Covers teaching methods, materials and literature for the independent studio teacher. Pre: consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3244 - Vocal Pedagogy (3 credits)
Exploration of historical and modern treatises. Implementation of technical methods to build vocal technique. Experimentation with biofeedback in pedagogical context. Practical application of pedagogical methods. Pre: Successful completion of continuation exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3314 - Instrumental Ensemble Music (1 credit)
Instruction and participation in instrumental music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 8 credit hours

MUS 3414 - Choral Ensemble Music (1 credit)
Instruction and participation in choral music performance ensembles under direction of members of the music faculty. Attention to technical proficiency, stylistic elements, musical design and interpretation in the works to be performed. Addresses ethical obligations and practice in a music ensemble setting. May be repeated for a combined maximum of 8 hours. Consent and audition required.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 8 credit hours

MUS 3814 - Jazz History (3 credits)
A survey and analysis of jazz music, including traditional jazz, big band, bebop, rhythm and blues, free jazz/avant garde, fusion, and hip-hop. Exploration of historical, social, and cultural forces and trends that influence the creation and interpretation of jazz music.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 3815 - Advanced Jazz Improvisation (2 credits)
Topics will include in-depth analysis of the great improvisers in multiple genres with a focus on developing professional-level skills.
Prerequisite(s): MUS 2816
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

MUS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4014 - Topics in Advanced Electroacoustic Research (3 credits)
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours.
Prerequisite(s): MUS 3066 and MUS 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

MUS 4014H - Topics Adv Electroacoustic Res (3 credits)
Rotating advanced research topics in electroacoustic music. Sonification, spatialization, algorithmic music, electronic music instrument design, digital performance ensembles, and advanced computer music composition. Repeatable with different content up to a maximum of 12 credit hours.
Prerequisite(s): MUS 3066 and MUS 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

MUS 4055 - Music Technology Senior Seminar (1 credit)
Weekly seminars in music technology with group discussion of progress in current student projects, the current state of artistic and business practices in the recording industry, and guest lecturers drawn from the professional world.
Prerequisite(s): MUS 3056
Instructional Contact Hours: (1 Lec, 1 Crd)

MUS 4056 - Music Technology Senior Seminar (1 credit)
Weekly seminars in music technology with group discussion of progress in current student projects, the current state of artistic and business practices in the recording industry, and guest lecturers drawn from the professional world.
Prerequisite(s): MUS 3056
Instructional Contact Hours: (1 Lec, 1 Crd)

MUS 4124 - Special Topics in Music History and Literature (3 credits)
Specific, in depth study of one of several topics in music history and or literature.
Prerequisite(s): MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 4174 - Topics in Musicology (3 credits)
Examine topics in historical musicology and their interdisciplinary resonance. Examination of primary sources, top musicology journals, and monographs as appropriate. Historical and technical analysis of music. Investigation of historical and sociocultural context of music. May be repeated 2 times with different content for a maximum of 9 credit hours.
Prerequisite(s): MUS 3174
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MUS 4204 - Secondary General and Choral Music Education Methods (3 credits)
This course examines philosophical, planning, administrative, organizational, instructional methods, assessment of student learning and cultural performances necessary to manage and teach secondary general and choral music programs.
Prerequisite(s): MUS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

MUS 4214 - Instrumental Methods: Elementary (2 credits)
Develop skills and practices to direct an elementary instrumental music program in a school setting. Learn practices, procedures, and strategies for leading rehearsals and lessons, developing curriculum, assessing student learning, and administering a school instrumental program.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4224 - Instrumental Methods: Secondary (2 credits)
Develop skills and practices to direct an instrumental music program in a middle or high school setting. Learn practices, procedures, and strategies for leading rehearsals and lessons, developing curriculum, assessing student learning, and administering a school instrumental music program.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4234 - Topics in Music Education (2 credits)
Study of specialized areas of pedagogy, instruction, administration, and classroom management in music education. Prepares students to lead specialized ensembles and courses in school music contexts. Course can only be taken one time for credit toward degree requirements.
Prerequisite(s): MUS 2364
Instructional Contact Hours: (2 Lec, 2 Crd)

MUS 4514 - Advanced Individual Applied Voice (1-3 credits)
Individual instruction in voice at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2514
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4524 - Advanced Individual Applied Keyboard (1-3 credits)
Individual instruction in keyboard at an advanced level. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2524
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4534 - Advanced Individual Applied Violin (1-3 credits)
Individual instruction in violin at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2534
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4544 - Advanced Individual Applied Viola (1-3 credits)
Individual instruction in viola at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2544
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4554 - Advanced Individual Applied Cello (1-3 credits)
Individual instruction in cello at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2554
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4564 - Advanced Individual Applied Bass (1-3 credits)
Individual instruction in bass at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2564
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4574 - Advanced Individual Applied Flute (1-3 credits)
Individual instruction in flute at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2574
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4584 - Advanced Individual Applied Oboe (1-3 credits)
Individual instruction in oboe at an advanced level. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2584
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4594 - Advanced Individual Applied Clarinet (1-3 credits)
Individual instruction in clarinet at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2594
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4614 - Advanced Individual Applied Saxophone (1-3 credits)
Individual instruction in saxophone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2614
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 4624 - Advanced Individual Applied Bassoon (1-3 credits)
Individual instruction in bassoon at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2624
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4634 - Advanced Individual Applied Horn (1-3 credits)
Individual instruction in horn at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2634
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4644 - Advanced Individual Applied Trumpet (1-3 credits)
Individual instruction in trumpet at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2644
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4654 - Advanced Individual Applied Trombone (1-3 credits)
Individual instruction in trombone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2654
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4664 - Advanced Individual Applied Baritone (1-3 credits)
Individual instruction in baritone at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2664
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4674 - Advanced Individual Applied Tuba (1-3 credits)
Individual instruction in tuba at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2674
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4684 - Advanced Individual Applied Percussion (1-3 credits)
Individual instruction in percussion at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2684
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4734 - Advanced Individual Applied Composition (1-3 credits)
Individual instruction in composition at an advanced level. Majors only. May be repeated. Performance continuation exam required.
Prerequisite(s): MUS 2734
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

MUS 4744 - Advanced Individual Applied Conducting (1-3 credits)
Individual instruction in conducting at an advanced level. May be repeated. Consent required.
Prerequisite(s): MUS 2744
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

MUS 4754 - Advanced Individual Applied Recording (1-3 credits)
Individual instruction through directed experiential learning in music recording and production at an advanced level. Integration of critical listening, acoustics, audio recording, signal processing, audio mixing, and audio mastering with music theory and performance. An emphasis in hands-on exploratory research in the use of instruments, acoustics, microphones, recording, and production techniques combined with traditional methods and emerging technologies to capture and produce recordings in an artistic manner suitable for use in a senior portfolio. Permission required. May be repeated for a maximum of 12 hours.
Prerequisite(s): MUS 2754
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 12 credit hours

MUS 4764 - Advanced Individual Applied Electroacoustics (1 credit)
Individual instruction and completion of a major project in electroacoustic composition, performance, or research, at an advanced level. Repeatable up to three times for a maximum of 3 credit hours.
Prerequisite(s): MUS 3064 and MUS 3066
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

MUS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MUS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Music Major with Composition Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3

MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select two of the following:		6
MUS 3024	Counterpoint	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Advanced Music History Literature		
Select one of the following:		3
MUS 3114	Symphonic Literature	
MUS 3124	20th Century Music Literature	
MUS 3134	Vocal Music Literature	
MUS 3144	Early Music Literature	
MUS 3154	Piano Literature	
MUS 3164	History of Electronic Music	
MUS 4174	Topics in Musicology	
Composition		
MUS 2065	Music Composition	2
MUS 2066	Music Composition	2
MUS 2734	Individual Applied Composition	2
MUS 2734	Individual Applied Composition	2
MUS 4734	Advanced Individual Applied Composition (repeatable course taken four times for two credits each time)	8
Performance (Lower Division) [1]		
Select six hours (taken twice for two credits and twice for one credit) of the following:		6
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Technology		
Select six hours of the following:		6
MUS 3064	Digital Sound Manipulation	
MUS 3065	Computer Music and Multimedia Design	
MUS 3066	Computer Music and Multimedia Design	
Performance (Ensemble)		
Select four credits of the following (repeatable courses to be taken four times for one credit each time):		4
MUS 3314	Instrumental Ensemble Music	
MUS 3414	Choral Ensemble Music	
Performance (Related)		
MUS 3225	Conducting	3
MUS 2815	Jazz Improvisation	2
Other Requirements		
Department will process transaction when requirements have been met		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Senior Recital		
Subtotal		52
Free Electives		
Select remaining credits to complete 120 credit hours required for degree:		12
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) will be fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3

Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) will be satisifed by completing MUS 3314	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) will be fulfilled by completing MUS 3194 [2]	
Subtotal	33
Total Credits	**120**

[1] All courses are VAR Credit
[2] May be double counted with another concept

Satisfactory Progress Toward Degree

In addition to university requirements, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam requirement		
Keyboard Proficiency Requirement		
Convocation and Concert Attendance Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (complete two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites: Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Creative Technologies in Music Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select one of the following:		3
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History Literature		
MUS 3164	History of Electronic Music	3
Performance (Ensemble)		
Select four credits of one of the following: (repeatable courses) Students in this degree option are encouraged to choose MUS 3314 L2Ork		4
MUS 3314	Instrumental Ensemble Music	
MUS 3414	Choral Ensemble Music	
Technologies		
Select twelve credit hours from the following:		12
MUS 3064	Digital Sound Manipulation	
MUS 3065	Computer Music and Multimedia Design	
MUS 3066	Computer Music and Multimedia Design	

MUS 4014	Topics in Advanced Electroacoustic Research (repeatable with different content)	
Area of Study		
Select one of the following areas:		9
Research		
MUS 4014	Topics in Advanced Electroacoustic Research (Repeatable with different content)	
MUS 4994	Undergraduate Research	
MUS 4764	Advanced Individual Applied Electroacoustics (Repeatable up to three times for maximum of three credit hours)	
Senior Project [1]		
Composition		
MUS 2065	Music Composition	
MUS 2066	Music Composition	
MUS 2734	Individual Applied Composition	
MUS 2734	Individual Applied Composition	
One credit of Music Elective (any music course with the exception of MUS 1005, MUS 1006, MUS 1104, MUS 2115, MUS 2116)		
Subtotal		31
Free Electives		
Select remaining credit hours to satisfy degree requirements.		27
Subtotal		27
Other Requirements		
Department will process transaction when requirements have been met		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
3 credits of pathways concept 2 will be satisfied by completing MUS 3164 as part of option requirements		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3314		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [2]		3
Subtotal		39
Total Credits		**120**

[1] Department will process transaction when requirement has been met.
[2] May be double-counted with another concept

Satisfactory Progress Toward Degree

In addition to University requirements, students must complete the following by the end of the semester in which they attempt 54 credit hours.

Code	Title	Credits
Continuation Exam requirement		
Keyboard Proficiency Requirement		
Convocation and Concert Attendance Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Music Education Choral/General Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
MUS 3044	Orchestration & Analysis	3
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Performance (Lower Division)		
Select four credits (repeatable course taken four times for one credit each time) of the following: [1]		4
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Upper Division)		
Select eight credits (repeatable courses taken four times for two credits each time) of the following: [1]		8
MUS 4514	Advanced Individual Applied Voice	
MUS 4524	Advanced Individual Applied Keyboard	
MUS 4534	Advanced Individual Applied Violin	
MUS 4544	Advanced Individual Applied Viola	
MUS 4554	Advanced Individual Applied Cello	
MUS 4564	Advanced Individual Applied Bass	
MUS 4574	Advanced Individual Applied Flute	
MUS 4584	Advanced Individual Applied Oboe	
MUS 4594	Advanced Individual Applied Clarinet	
MUS 4614	Advanced Individual Applied Saxophone	
MUS 4624	Advanced Individual Applied Bassoon	
MUS 4634	Advanced Individual Applied Horn	
MUS 4644	Advanced Individual Applied Trumpet	
MUS 4654	Advanced Individual Applied Trombone	
MUS 4664	Advanced Individual Applied Baritone	
MUS 4674	Advanced Individual Applied Tuba	
MUS 4684	Advanced Individual Applied Percussion	
Performance (Ensemble)		
Repeatable course taken eight times for one credit each time		8
MUS 3414	Choral Ensemble Music	
Take all twenty eight hours of the following:		
MUS 2214	Class Applied Piano	1
MUS 2214	Class Applied Piano	1
MUS 2234	Class Applied Strings	1
MUS 2264	Class Applied Percussion	1
MUS 2314	Woodwind Techniques I - Flute, Clarinet, Saxophone	1
or MUS 2324	Woodwind Techniques II - Oboe and Bassoon	
MUS 2334	High Brass Techniques	1
MUS 2344	Low Brass Techniques	1
MUS 2364	Introduction to Music Education	2
MUS 2515	Vocal Diction	1
MUS 2516	Vocal Diction	1
MUS 3214	Teaching Music in the Elementary School	3
MUS 3225	Conducting	3
MUS 3226	Conducting	3
MUS 3244	Vocal Pedagogy	3
MUS 4204	Secondary General and Choral Music Education Methods	3
MUS 4214	Instrumental Methods: Elementary	2
or MUS 4224	Instrumental Methods: Secondary	
Education		
MUS 4964	Field Study (P/F Only)	3
Elective Courses		
Select one of the following:		2
MUS 2815	Jazz Improvisation	
MUS 4234	Topics in Music Education	

Subtotal	62
Free Elective Credits	
Select the minimum number of elective credits to satisfy the 120 total credit hours:	2
Subtotal	2
Other Requirements	
Department will process transaction when requirements have been met	
Keyboard Proficiency	
Continuation Exam	
Convocation and Concert Attendance	
Junior Recital	
Pathways to General Education	
Pathways Concept 1 - Discourse	
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)	3
Pathways Concept 2 - Critical Thinking in the Humanities	
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194	
Pathways Concept 3 - Reasoning in the Social Sciences	
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Three credits of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3414	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194	
Subtotal	33
Total Credits	**120**

[1] All courses are VAR Credit

Satisfactory Progress Toward Degree

To comply with the "Satisfactory progress toward degree" requirement, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (complete 2 hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals , MUS 1006 Theory Fundamentals , MUS 1104 Music Appreciation , MUS 2115 Survey of Western Music , and MUS 2116 Survey of Western Music .

Prerequisites

Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Music Education Instrumental Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1

MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
MUS 3044	Orchestration & Analysis	3
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Performance (Lower Division)		
Select four credits (repeatable course to be taken four time for one credit each time) of the following: [1]		4
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Upper Division)		
Select eight credits (repeatable courses to be taken four times for two credits each time) of the following: [1]		8
MUS 4514	Advanced Individual Applied Voice	
MUS 4524	Advanced Individual Applied Keyboard	
MUS 4534	Advanced Individual Applied Violin	
MUS 4544	Advanced Individual Applied Viola	
MUS 4554	Advanced Individual Applied Cello	
MUS 4564	Advanced Individual Applied Bass	
MUS 4574	Advanced Individual Applied Flute	
MUS 4584	Advanced Individual Applied Oboe	
MUS 4594	Advanced Individual Applied Clarinet	
MUS 4614	Advanced Individual Applied Saxophone	
MUS 4624	Advanced Individual Applied Bassoon	
MUS 4634	Advanced Individual Applied Horn	
MUS 4644	Advanced Individual Applied Trumpet	
MUS 4654	Advanced Individual Applied Trombone	
MUS 4664	Advanced Individual Applied Baritone	
MUS 4674	Advanced Individual Applied Tuba	
MUS 4684	Advanced Individual Applied Percussion	
Performance (Ensemble)		
Repeatable course taken eight times for one credit each time		8
MUS 3314	Instrumental Ensemble Music	
Take all twenty seven credit hours:		
MUS 2214	Class Applied Piano	1
MUS 2214	Class Applied Piano	1
MUS 2224	Class Applied Voice	1
MUS 2234	Class Applied Strings	1
MUS 2264	Class Applied Percussion	1
MUS 2314	Woodwind Techniques I - Flute, Clarinet, Saxophone	1
MUS 2324	Woodwind Techniques II - Oboe and Bassoon	1
MUS 2334	High Brass Techniques	1
MUS 2344	Low Brass Techniques	1
MUS 2364	Introduction to Music Education	2
MUS 3214	Teaching Music in the Elementary School	3
MUS 3225	Conducting	3
MUS 3226	Conducting	3
MUS 4204	Secondary General and Choral Music Education Methods	3
MUS 4214	Instrumental Methods: Elementary	2
MUS 4224	Instrumental Methods: Secondary	2
Education		
MUS 4964	Field Study (P/F Only)	3
Elective Courses		
MUS 2815	Jazz Improvisation	2
or MUS 4234	Topics in Music Education	
Subtotal		61
Free Electives		
Select the minimum number of elective credits to satisfy the 120 total credit hours:		3
Subtotal		3
Other Requirements		
Department will process transaction when requirements have been met		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6

Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3314	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194 [2]	
Subtotal	33
Total Credits	**120**

[1] All courses are VAR Credit

[2] May be double-counted with another concept

Satisfactory Progress Toward Degree

To comply with the "Satisfactory progress toward degree" requirement, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Performance Liberal Arts Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select one of the following:		3
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
or MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	
Performance (Lower Division)		
Select seven credits (repeatable courses taken three times for two credits and one time for one credit) of the following, all VAR credit:		7
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	

MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Upper Division)		
Select eight credits (repeatable courses taken four times for two credits each time) of the following, all VAR credit:		8
MUS 4514	Advanced Individual Applied Voice	
MUS 4524	Advanced Individual Applied Keyboard	
MUS 4534	Advanced Individual Applied Violin	
MUS 4544	Advanced Individual Applied Viola	
MUS 4554	Advanced Individual Applied Cello	
MUS 4564	Advanced Individual Applied Bass	
MUS 4574	Advanced Individual Applied Flute	
MUS 4584	Advanced Individual Applied Oboe	
MUS 4594	Advanced Individual Applied Clarinet	
MUS 4614	Advanced Individual Applied Saxophone	
MUS 4624	Advanced Individual Applied Bassoon	
MUS 4634	Advanced Individual Applied Horn	
MUS 4644	Advanced Individual Applied Trumpet	
MUS 4654	Advanced Individual Applied Trombone	
MUS 4664	Advanced Individual Applied Baritone	
MUS 4674	Advanced Individual Applied Tuba	
MUS 4684	Advanced Individual Applied Percussion	
Performance (Ensemble)		
Select eight credits (taken eight times for one credit each time) of the following: (repeatable courses)		8
MUS 3314	Instrumental Ensemble Music	
MUS 3414	Choral Ensemble Music	
Subtotal		29
Free Electives		
32 credits		32
Subtotal		32
Other Requirements		
Department will process transaction when requirements have been met:		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Three credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by MUS 3184 or MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by MUS 3314		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by MUS 3194 [1]		
Subtotal		36
Total Credits		**120**

[1] May be double counted with another concept

Satisfactory Progress Toward Degree

To comply with the "Satisfactory progress toward degree" requirement, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3

MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Performance Professional Instrumental Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select two of the following:		6
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Advanced Music History Literature		
Select one of the following:		3
MUS 3114	Symphonic Literature	
MUS 3124	20th Century Music Literature	
MUS 3134	Vocal Music Literature	
MUS 3144	Early Music Literature	
MUS 3154	Piano Literature	
MUS 4174	Topics in Musicology	
Performance (Lower Division)		
Select eight credits (repeatable courses, taken four times for two credits each time) of the following:		8
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Upper Division)		
Select eight credits (repeatable courses, taken four times for two credits each time) of the following:		8
MUS 4514	Advanced Individual Applied Voice	
MUS 4524	Advanced Individual Applied Keyboard	
MUS 4534	Advanced Individual Applied Violin	
MUS 4544	Advanced Individual Applied Viola	
MUS 4554	Advanced Individual Applied Cello	
MUS 4564	Advanced Individual Applied Bass	
MUS 4574	Advanced Individual Applied Flute	
MUS 4584	Advanced Individual Applied Oboe	
MUS 4594	Advanced Individual Applied Clarinet	
MUS 4614	Advanced Individual Applied Saxophone	
MUS 4624	Advanced Individual Applied Bassoon	
MUS 4634	Advanced Individual Applied Horn	
MUS 4644	Advanced Individual Applied Trumpet	
MUS 4654	Advanced Individual Applied Trombone	
MUS 4664	Advanced Individual Applied Baritone	
MUS 4674	Advanced Individual Applied Tuba	

MUS 4684	Advanced Individual Applied Percussion	
Performance (Ensemble)		
Select eight credits (repeatable courses, taken eight times for one credit each time) of the following:		8
MUS 3314	Instrumental Ensemble Music [1]	
or MUS 3414	Choral Ensemble Music	
Performance (Related)		
MUS 2815	Jazz Improvisation	2
MUS 3225	Conducting	3
MUS 3226	Conducting	3
Elective Courses		
Select five credits of MUS courses excluding the following:		5
MUS 1005	Theory Fundamentals	
MUS 1006	Theory Fundamentals	
MUS 1104	Music Appreciation	
MUS 2115	Survey of Western Music	
MUS 2116	Survey of Western Music	
MUS 3314	Instrumental Ensemble Music	
MUS 3414	Choral Ensemble Music	
Subtotal		52
Other Requirements		
Department will process transaction when requirements have been met:		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Senior Recital		
Free Electives		
Select the minimum number of elective credits to satisfy the 120 total credit hours:		12
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3314		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194 [2]		
Subtotal		33
Total Credits		**120**

[1] 2 hours must be designated "Chamber Music" sections

[2] May be double counted with another concept

Satisfactory Progress Toward Degree

To comply with the “Satisfactory progress toward degree” requirement, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
Select two hours:		2
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. CLE).

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Performance Professional Vocal Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select two of the following:		6
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History Literature		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Advanced Music History Literature		
Select one of the following:		3
MUS 3114	Symphonic Literature	
MUS 3124	20th Century Music Literature	
MUS 3134	Vocal Music Literature	
MUS 3144	Early Music Literature	
MUS 3154	Piano Literature	
MUS 4174	Topics in Musicology	
Performance (Lower Division)		
Select eight credits (repeatable course, taken four times for two credits each time) of the following:		8
MUS 2514	Individual Applied Voice	
Performance (Upper Division)		
Select eight credits (repeatable course, taken four times for two credits each time) of the following:		8
MUS 4514	Advanced Individual Applied Voice	
Performance (Ensemble)		
Select eight credits (repeatable course, taken eight times for one credit each time) of the following:		8
MUS 3414	Choral Ensemble Music	
Performance (Language)		
Select two of the following:		6
GER 1105	Elementary German	
GER 1106	Elementary German	
GER 2105	Intermediate German	
FR 1105	Elementary French	
FR 1106	Elementary French	
FR 2105	Intermediate French	
ITAL 1105	Elementary Italian	
ITAL 1106	Elementary Italian	
ITAL 2105	Intermediate Italian	
Performance (Related)		
MUS 2515	Vocal Diction	1
MUS 2516	Vocal Diction	1
MUS 2815	Jazz Improvisation	2
MUS 3225	Conducting	3
MUS 3244	Vocal Pedagogy	3
Subtotal		55
Free Electives		
Select the minimum number of elective credits to satisfy the 120 total credit hours:		9
Subtotal		9
Other Requirements		
Department will process transaction when requirements have been met:		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Junior Recital		
Senior Recital		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		

Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3414	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194 [1]	
Subtotal	33
Total Credits	**120**

[1] May be double counted with another concept

Satisfactory Progress Toward Degree

To comply with the "Satisfactory progress toward degree" requirement, students must complete the following by the end of the semester in which they attempt 54 hours.

Code	Title	Credits
Continuation Exam Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Technology Liberal Arts Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select one of the following:		3
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History		
Select one of the following:		3
MUS 3184	Histories of Music I: Music in the European and American Traditions	
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	
Performance (Lower Division)		
Select four credits (repeatable course, taken four times for one credit each time) of the following:		4
MUS 2514	Individual Applied Voice	

MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Ensemble)		
Select six credits (repeatable course, taken six times for one credit each time) of the following:		6
MUS 3314	Instrumental Ensemble Music	
or MUS 3414	Choral Ensemble Music	
Technology		
Select 12 credit hours of the following:		12
MUS 2055	Audio Technology For Music	
MUS 2056	Audio Technology For Music	
MUS 3055	Music and Media Production	
MUS 3056	Music and Media Production	
MUS 3065	Computer Music and Multimedia Design	
MUS 3066	Computer Music and Multimedia Design	
Technology (Project)		
MUS 2754	Individual Applied Recording	1
MUS 4754	Advanced Individual Applied Recording	2
Subtotal		31
Free Electives		
Select the minimum number of elective credits to satisfy the 120 total credit hours:		33
Subtotal		33
Other Requirements		
Department will process transaction when requirements have been met:		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Senior Recital		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3314		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194 [1]		
Subtotal		33
Total Credits		**120**

[1] May be double counted with another concept

Satisfactory Progress Toward Degree

In addition to University requirements, students must complete the following by the end of the semester in which they attempt 54 credit hours.

Code	Title	Credits
Continuation Exam requirement		
Keyboard Proficiency Requirement		
Convocation and Concert Attendance Requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.0 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Music Major with Technology Professional Option

Code	Title	Credits
Degree Core Requirements		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3035	Advanced Class Piano	1
MUS 3036	Advanced Class Piano	1
MUS 3045	Advanced Ear Training	1
MUS 3046	Advanced Ear Training	1
MUS 3174	Music as Global Culture	3
Subtotal		21
Major Requirements		
MUS 2054	Introduction to Music Technology	2
Subtotal		2
Option Required Courses		
Advanced Music Theory		
Select six credits from the following:		6
MUS 3024	Counterpoint	
MUS 3034	Form and Analysis in the Common-practice Period	
MUS 3044	Orchestration & Analysis	
MUS 3054	Introduction to Vocal/choral Arranging	
MUS 3074	Topics in Music Analysis	
Advanced Music History		
MUS 3184	Histories of Music I: Music in the European and American Traditions	3
MUS 3194	Histories of Music II: Music in the 20th and 21st Centuries	3
Advanced Music History Literature		
Select three credits from the following:		3
MUS 3114	Symphonic Literature	
MUS 3124	20th Century Music Literature	
MUS 3134	Vocal Music Literature	
MUS 3144	Early Music Literature	
MUS 3154	Piano Literature	
MUS 4174	Topics in Musicology	
Performance (Lower Division)		
Select four credits (repeatable course, taken four times for one credit each time) of the following:		4
MUS 2514	Individual Applied Voice	
MUS 2524	Individual Applied Keyboard	
MUS 2534	Individual Applied Violin	
MUS 2544	Individual Applied Viola	
MUS 2554	Individual Applied Cello	
MUS 2564	Individual Applied Bass	
MUS 2574	Individual Applied Flute	
MUS 2584	Individual Applied Oboe	
MUS 2594	Individual Applied Clarinet	
MUS 2614	Individual Applied Saxophone	
MUS 2624	Individual Applied Bassoon	
MUS 2634	Individual Applied Horn	
MUS 2644	Individual Applied Trumpet	
MUS 2654	Individual Applied Trombone	
MUS 2664	Individual Applied Baritone	
MUS 2674	Individual Applied Tuba	
MUS 2684	Individual Applied Percussion	
Performance (Upper Division)		
Select three credits (repeatable course, taken three times for one credit each time) of the following:		3
MUS 4514	Advanced Individual Applied Voice	
MUS 4524	Advanced Individual Applied Keyboard	
MUS 4534	Advanced Individual Applied Violin	
MUS 4544	Advanced Individual Applied Viola	
MUS 4554	Advanced Individual Applied Cello	
MUS 4564	Advanced Individual Applied Bass	
MUS 4574	Advanced Individual Applied Flute	
MUS 4584	Advanced Individual Applied Oboe	
MUS 4594	Advanced Individual Applied Clarinet	
MUS 4614	Advanced Individual Applied Saxophone	
MUS 4624	Advanced Individual Applied Bassoon	
MUS 4634	Advanced Individual Applied Horn	
MUS 4644	Advanced Individual Applied Trumpet	
MUS 4654	Advanced Individual Applied Trombone	
MUS 4664	Advanced Individual Applied Baritone	
MUS 4674	Advanced Individual Applied Tuba	
MUS 4684	Advanced Individual Applied Percussion	
Performance (Ensemble)		

Select six credits (repeatable course, taken six times for one credit each time) of the following:		6
MUS 3314	Instrumental Ensemble Music	
or MUS 3414	Choral Ensemble Music	
Technology		
MUS 2055	Audio Technology For Music	3
MUS 2056	Audio Technology For Music	3
MUS 3055	Music and Media Production	3
MUS 3056	Music and Media Production	3
Technology (Extended)		
MUS 4055	Music Technology Senior Seminar	1
MUS 4056	Music Technology Senior Seminar	1
MUS 2754	Individual Applied Recording	3
MUS 4754	Advanced Individual Applied Recording	2
Select one of the following:		*3*
MUS 2604	Introduction to Arts Marketing	
MUS 3064	Digital Sound Manipulation	
MUS 4014	Topics in Advanced Electroacoustic Research	
MUS 4964	Field Study (P/F only)	
TA 2164	Scene Design Lab	
Subtotal		50
Free Electives		
Select remaining credit hours to fulfill remaining credits required for graduation:		14
Subtotal		14
Other Requirements		
Department will process transaction when requirements have been met:		
Keyboard Proficiency		
Continuation Exam		
Convocation and Concert Attendance		
Senior Project		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) fulfilled by completing MUS 3184 and MUS 3194		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) fulfilled by completing MUS 3314		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MUS 3194 [1]		
Subtotal		33
Total Credits		**120**

[1] May be double counted with another concept

Satisfactory Progress Toward Degree

In addition to University requirements, students must complete the following by the end of the semester in which they attempt 54 credit hours.

Code	Title	Credits
Continuation Exam requirement		
MUS 2025	European-American Music Theory	3
MUS 2026	European-American Music Theory	3
MUS 2045	Sightsinging Laboratory	1
MUS 2046	Sightsinging Laboratory	1
MUS 3025	European-American Music Analysis	3
MUS 3026	European-American Music Analysis	3
MUS 3174	Music as Global Culture	3
MUS 3314	Instrumental Ensemble Music (two hours)	1
or MUS 3414	Choral Ensemble Music	

Graduation Requirements

GPA Requirements

To fulfill graduation requirements in the major, all courses used to fulfill requirements in the major must be completed with a grade of C or better. None of these courses may be repeated more than once for the purposes of raising the grade to C or better.

An overall and in-major GPA of 2.00 or higher is required. All Music courses are used in calculating the major GPA except MUS 1005 Theory Fundamentals, MUS 1006 Theory Fundamentals, MUS 1104 Music Appreciation, MUS 2115 Survey of Western Music, and MUS 2116 Survey of Western Music.

Prerequisites

Some courses listed on this check sheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Foreign Language Requirement

Students who do not successfully complete at least 2 units of a single language, classical language, or American Sign Language during high school must successfully complete 6 semester hours of a single college level language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

School of Visual Arts

Our Website (http://www.sova.vt.edu)

Overview

The School of Visual Arts (SOVA) offers studio-based programs in the visual arts balanced with the study of the history, theory, and criticism of visual and material culture. The faculty includes both practicing artists and scholars of art history. The School emphasizes new digital media as well as traditional artistic media. SOVA offers B.F.A. degrees in Graphic Design, Creative Technologies, and Studio Art; a B.A. in Art History, a minor in Art History and a minor in Visual Arts.

SOVA provides a variety of exhibitions and art events. The Armory Art Gallery exhibits work by national and regional artists and provides students and regional artists the opportunity to create and show wide-ranging experimental work. The Collaboration for Creative Technologies in Arts and Design (CCTAD) is a cross-disciplinary initiative with Art, Music, Computer Science and Communications. The Digital Arts and Animation Studio (DAAS) is designed to facilitate this new concentration.

FourDesign, a University Service Center, provides students with vital professional design experience. Student interns work in a team environment under the direction of FourDesign faculty to produce design work for clients, providing professional and entrepreneurial experience rarely available to undergraduates. Through visiting artists and scholars, the School also brings students and members of the art community into dialogue with artists and critics of international prominence.

SOVA participates in the University's Education Abroad program, which is open to students at the sophomore level or above and combines classroom study with travel-study tours in Europe, Cuba, and Latin America.

Foundations of Art and Design is a year-long, entry-level intensive program that prepares students for advanced study in the visual fields of integrative Studio Art, Creative Technologies and Graphic Design. The two-semester, 1000-level curriculum is made up of 15 credit hours covering principles of art and design, drawing, and digital imaging proficiency. Completion of the entire Foundation program is required of B.F.A. students prior to taking SOVA courses that are 2000 level or higher.

The investigation and unification of dexterity, contextual dialogue, and presentation skills are at the heart of the Foundations of Art and Design program at SOVA. Rather than isolating craft at the foundational level of study, whole elements of visual language are fostered equally. This unified approach to art and design studies aim to develop:

- Innovation and creative leadership skills
- Visual logic through multimedia
- Confidence with digital and analog crossover
- Traditional awareness applicable to contemporary tools of production

Studio Art, Creative Technologies, and Graphic Design candidates must be currently enrolled or have passed three foundation courses (ART 1204 Principles of 2D Art and Design, ART 1404 Principles of Drawing and ART 1604 Principles of 4D Art & Design). Acceptance is contingent on successfully passing all three of these courses. The Studio Art, Creative Technologies, and Graphic Design review committees (comprised of SOVA Faculty) screen student work for outstanding qualities in artistic ability, creativity, presentation skills and overall motivation.

Bachelor of Fine Arts in Studio Art

The SOVA Studio Art program offers classes in painting, drawing, sculpture, and photography. We aim to prepare artists for the digitally enhanced world by integrating emerging technologies into a contemporary fine arts experience. Our students have access to cutting edge technologies like laser cutters, CNC routers and 3D printers, and are taught in an environment that encourages them to explore these tools in conjunction with traditional mediums. Students and faculty conduct research and create work that spans disciplinary boundaries. Our flexible undergraduate curriculum provides opportunities for students to achieve interdisciplinary breadth through electives in Graphic Design, Creative Technologies, and other areas of personal interest.

Situated within a nationally recognized research institution, SOVA attracts students and faculty who value the study of art in a broad cultural and intellectual context. The B.F.A. degree in Studio Art equips emerging artists with critical thinking skills, visual and cultural literacy, and tools to communicate their ideas. We also promote the professional skills and habits necessary to build and sustain a self-directed studio practice. Our program is uniquely positioned to provide students with the skills and opportunities to explore the impact of art and technology on our lived experience.

Graduates of the Studio Art program apply their creative skills in a variety of careers. Some become professional artists, exhibiting at national galleries and museums, or pursue commercial careers in photography, painting, illustration, and sculpture. Others seek their Master of Fine Arts (M.F.A.) in specific studio disciplines or post-graduate degrees in related arts fields such as Material Culture, Art Therapy, Art Education, Exhibition Design, and Art Conservation. Our alumni have gone on to become professional artists, university professors, K-12 teachers, and pursue careers in galleries and museums.

The Bachelor of Fine Arts degree in Studio Art is a 78 credit-hour program. Each faculty member is dedicated to teaching, research, and outreach within his or her specific fields. The connection from professional practice to studio classroom is essential in creating applicable learning environments.

The goal of the program is to develop culture-enriching leaders and innovative visual artists. Completing an integrated path of study in the Studio Art program will result in a B.F.A. degree that is applicable to the demands of the visual arts industry.

Bachelor of Fine Arts in Creative Technologies

The Creative Technologies program focuses on computer-based digital arts, including animation, creative coding, interactive installations, etc. Classes are taught by active artists and scholars with experience integrating emerging creative technologies into new media art contexts as well as applications in industry.

The Creative Technologies concentration consists of 75 credit hours, with 21 required credits and additional elective offerings that can be clustered so that students obtain specialization in immersive virtual environments, code and form or the moving image.

In the Creative Technologies program, students learn cutting-edge software in a creative environment, preparing them for employment in industry or further studies in graduate school.

Bachelor of Fine Arts in Graphic Design

The Graphic Design program is notable for its practical and applied approach to design thinking. Students concentrating in Graphic Design develop conceptual abilities, problem solving skills, and the technical know-how required by a fast-paced, competitive field. Graphic Design demands individual creativity, teamwork skills, and adaptability to changing markets and technologies. The Graphic Design program at Virginia Tech prepares students for the job market with practical experience, professional portfolio preparation, and an understanding of user-experience design. Graduates of the program may find themselves working in design agencies, UI/UX, product and packaging design, and advertising design. Coursework in animation, web design, and interaction allows students to explore emerging technologies.

Entry into this program is restricted and requires successful completion of specific criteria. Students accepted into Graphic Design begin the course sequence in the spring semester of their first year. From that point on, the course sequences are uniquely tailored to Graphic Design students, which emphasize typography, design, and applied technologies.

Bachelor of Arts in Art History and Visual Culture

This program is oriented toward the history of western art, although courses are frequently offered on non-western topics. The foundation for the study of art history in SOVA is a two-semester survey of the history of art. At the intermediate level, there are fourteen courses offered on a regular basis, ranging from ancient Egyptian art and architecture to Art Since 1900, and including archaeology, arts of China and Japan, and the history of graphic design. Upper-level courses are designated as special topics courses. In recent years, they have ranged from the Seven Wonders of the World to Japanese prints to the History of Photography to the Preservation of Historic Interiors.

The major in Art History and Visual Culture is a 42-credit degree. In addition to the two semester Survey of the History of Art (ART 2385 Survey of the History of Western Art-ART 2386 Survey of the History of Western Art), students are required to take five courses at the 3000-level. The five courses are chosen from a list of four historical categories, ensuring students study art and architectural history over a broad historical range. In addition, majors are required to take ART 4484 Topics in Art Criticism and Methodology and three upper-level topics classes (ART 4384 Topics in Art History).

To provide a broader context for the history of art, majors are also required to take a history course and a humanities course (focusing on broad cultural and historical periods). To ensure some 'hands on' experience, they are also required to take either ART 1204 Principles of 2D Art and Design or ART 1404 Principles of Drawing. The program encourages students to take advantage of opportunities to study abroad and to serve as interns in cultural organizations, especially museums and historical sites.

Minor in Art History

The minor in art history is an 18-credit degree. It consists of the two-semester Survey of the History of Art (ART 2385 Survey of the History of Western Art-ART 2386 Survey of the History of Western Art) and two courses at the 3000-level and two at the 4000-level.

Visual Arts Minor

Hosted by the School of Visual Arts with collaboration from numerous departments across Virginia Tech, the interdisciplinary Visual Arts Minor leads students to explore art as a lens through which to view society. It encourages the cultivation of visual intelligence—through both study and practice-based approaches in studio art—relevant to our increasingly visual, media-saturated world and demanded in a variety of STEM and humanities fields. Students learn flexible visual skills and how to apply them to multiple disciplines inside and outside their major, such as business, medicine, law, and the natural sciences. The result is a comprehensive understanding of art and the built environment in a global context, as they intersect with the complexities of historical and contemporary society.

Requirements for the Minor include four core courses—ART 1104 Language of Visual Arts, ART 1004 Topics in Studio Art for Non-Majors, ART 2385 Survey of the History of Western Art/ART 2386 Survey of the History of Western Art, ART 4104 Interpretation of Visual Arts—and two elective courses in the social sciences, totaling 18 credit hours.

- Art Major with Art History Option (p. 639)
- Creative Technologies Major (p. 641)
- Graphic Design Major (p. 643)
- Studio Art Major (p. 645)

Interim Director - School of Visual Arts: A-M. Knoblauch
Chair – Foundation Program: J. Hand
Chair – Studio Art: M. Borowski
Chair – Creative Technologies: R. Weaver
Chair – Graphic Design: M. Dee
Chair – Art History: M. Moseley
Manager – Visual Arts and Society Minor: J. Jewitt
Curator – Armory Gallery: D. Sim
Professor: E. Standley
Associate Professors: S. Blanchard, M. Dee, T. Head, A-M. Knoblauch, M. Moseley, T. Tucker
Assistant Professors: M. Borowski, Z. Duer, M. Drum, P. Finley, N. King, A. Lechner, K. Meaney, A. Ronan, W. Santos Lages, R. Weaver
Collegiate Associate Professor: J. Jewitt
Collegiate Assistant Professor: L. Duffield, H. Okumura, A. Salisbury
Associate Professor of Practice: J. Joiner
Instructors: B. Bannan, J. Hand, J. Rosenthal, D. Sim
Adjunct Instructors: D. Choi, D. Dennis, M. Miller
Professor Emeritus/Emerita: S. Bickley, C Burch-Brown, T. Capone, D. Crane, K. Concannon, B. Fields, R. Kass, B. Van Hook
Associate Professor Emerita: M. Casto, S. Paterson

Undergraduate Course Descriptions (ART)

ART 1004 - Topics in Studio Art for Non-Majors (3 credits)
Variable introductory topics on practice-based studio art, ranging from 2D, 3D and Digital Imaging concentrations. Multiple projects with emphasis on media specific creations using introductory studio practices, practice-based technical and conceptual knowledge to achieve expressive communication. Analyze and critique creative works within historical and cultural context. May be repeated with different topics, for a maximum of 12 credit hours. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). COURSE FEE: $60.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 1104 - Language of Visual Arts (3 credits)
Introduces key formal structures across the broad variety of disciplines in the visual arts and built environment, including: architecture, painting, sculpture, photography, and film. Considers global objects and sites from an intercultural perspective, examining how various formal elements impact our experience and function to construct meaning for audiences. Writing informed arts criticism grounded in local and regional cultural resources. RESOURCE CHARGE.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 1204 - Principles of 2D Art and Design (3 credits)
Elements and methods fundamental to two-dimensional art and design. Investigates formal elements and principles of two-dimensional design including shape, color, balance, rhythm, hierarchy, and unity. Exploration of analog and digital strategies in image making through iterative, hands-on processes. Interpretation of historical and contemporary two-dimensional art and design from around the globe to discover communication strategies in an intercultural context. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1214 - Principles of 3D Art and Design (3 credits)
Elements and methods fundamental to three-dimensional art and design. Investigates formal elements and principles of three-dimensional design including line, plane, form, mass, space, scale and surface. Exploration of analog and digital strategies in three-dimensional object making through iterative, hands-on processes. Interpretation of historical and contemporary three-dimensional art and design from around the globe to discover communication strategies in an intercultural context. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1234 - Topics in Visual Communication Design for Non-Majors (3 credits)
Variable introductory topics on visual communication design, ranging from contemporary issues in design to development of formal design skills. Multiple projects with emphasis on problem-solving with an awareness of target audiences from various backgrounds, historical and cultural contexts, and STEEP (Social, Technological, Economical, Environmental, and Political) principles. Explores knowledge of design principles and vocabulary using a range of materials and methodologies. Examines needs of diverse users, applied via digital translations and appropriate software. May be repeated for up to a maximum of 12 credit hours with varying or different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 1304 - Gateway to Art and Design (1 credit)
First Year Experience course for students seeking entry into BFA degree program. Developing a successful path of study in the School of Visual Arts BFA degree using advising resources; introduction to professional and ethical visual arts practices through presentations with local and regional artists; visits to local and regional galleries; presentations by university faculty and staff related to the BFA. Introduction to visual thinking using the Virginia Tech Common Book and preparation for portfolio review. Art History majors are not required to take the course.
Corequisite(s): ART 1204, ART 1404, ART 1604
Instructional Contact Hours: (1 Lec, 1 Crd)

ART 1334 - Themes in Visual Arts and Cultures (3 credits)
Introduction to thematic topics spanning historical and contemporary world cultures through the lens of the visual arts and material culture. Ten themes to be addressed each semester, each approached through a range of different periods, cultures, media, and artistic traditions, and complemented by culture-specific textual sources. Sample themes might include art and political propaganda, art and technology, art and sustainability, art and death, etc. Does not count towards the art history major.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 1404 - Principles of Drawing (3 credits)
Elements, methods and skills fundamental to drawing. Investigates formal elements fundamental to drawing such as line, space, form, value and texture, through drawing tools and methods. Emphasis on controlled use of common drawing media for representational and expressive purposes. Examination of multiple intercultural viewpoints through exercises and discussion investigating topics that vary by semester. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H,5L,3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1414 - Drawing II: Life Drawing (3 credits)
Drawing the human figure from life. Emphasis on observation, construction, and anatomy. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1404 and ART 1204 and ART 1604
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1504 - Contemporary Art and Practice (3 credits)
Methods and practices fundamental to the making of contemporary visual art. Non-discipline-specific investigation of self-expression, meaning, and content through iterative, practice-based exercises. Development of personal artistic practice through the lens of contemporary art and its historical precedents. Exploration of various processes such as representation, abstraction, assemblage, performance, installation, mark making, digital, and time-based, or interactive experiences as means to self-expression and interpretation of meaning. Examination of multiple worldviews and global challenges addressed in contemporary art. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). (1H, 5L, 3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1604 - Principles of 4D Art & Design (3 credits)
Elements and methods fundamental to digital art and design as well as time-based media. Investigation of formal elements specific to four-dimensional design including time, motion, and sound and skills sets in vector and raster graphics and video editing. Exploration of iterative process in digital image making. Interpretation of historical and contemporary digital art and time-based media from around the globe to discover communication strategies in an intercultural context. Examination of multiple worldviews and global challenges addressed in and relevant to digital art and time-based media such as surveillance and questions of privacy. Application of formal analysis and interpretive strategies through critique. Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE. (1H, 5L, 3C)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1614 - Principles of Visual Communication Design (3 credits)
Introduction to design theory, practice, and visual communication skills. Projects, applied problem solving, reading assignments, and open critiques incorporate graphic competencies and vocabulary specific to the field of visual communication design. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 1984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

ART 2385 - Survey of the History of Western Art (3 credits)
Survey of the visual arts and architecture from prehistoric times to the present day with emphasis on Western Europe including functions of visual arts and architecture, terms of visual literacy and methods of formal visual analysis. 2385: Focus on prehistoric time to the thirteenth century including Paleolithic, Neolithic, Ancient Near Eastern, Egyptian, Aegean, Greek, Roman, Byzantine, medieval and early Gothic art. 2386: Focus on late Gothic through present day including Renaissance, Baroque, 19th (Romanticism to Post-Impressionism) and 20th centuries (cubism to postmodernism).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 2386 - Survey of the History of Western Art (3 credits)
Survey of the visual arts and architecture from prehistoric times to the present day with emphasis on Western Europe including functions of visual arts and architecture, terms of visual literacy and methods of formal visual analysis. 2385: Focus on prehistoric time to the thirteenth century including Paleolithic, Neolithic, Ancient Near Eastern, Egyptian, Aegean, Greek, Roman, Byzantine, medieval and early Gothic art. 2386: Focus on late Gothic through present day including Renaissance, Baroque, 19th (Romanticism to Post-Impressionism) and 20th centuries (cubism to postmodernism).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 2434 - Introduction to Creative Code (3 credits)
Introduction to computer programming tools within a critical aesthetic context. Tools may include software such as Processing and Unity. Application of foundational programming techniques to artwork creation. Consideration of computational and quantitative technologies and processes ethically, culturally, and artistically. Algorithmic thinking, and examination of existing computer-generated artworks to infer algorithmic basis. Consideration of the ethics of algorithmic systems in our culture and media. Course contact to credit hour structure: Design Lab/Studio.
Prerequisite(s): ART 1604
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2514 - Drawing Concepts (3 credits)
Exploration of drawing practices that reflect expansions in the discipline through examination of the work of contemporary artists and discussion of recent historical precedents. Examination of multiple viewpoints through readings and discussion investigating notions of identity, culture, and social reality. Development of personalized visual language and content through iterative drawing processes. Application of formal analysis and interpretive strategies through critique. Includes traditional and experimental techniques; representational, abstract, and nonobjective approaches to drawing. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1404
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2524 - Introduction To Painting (3 credits)
Exploration of painting practices within a studio-focused environment as they relate to art and design in contemporary culture as well as historical methods. Development of foundational painting skills and an understanding of various painting media. Deliberate practice of visual language and formal ideas using painting media with a focus on material, line, shape, color, and two-dimensional composition. Interpretation of visual culture through the application of critical analysis methods. Encompasses observation-based techniques, experimental processes, and abstract approaches. Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE: $75
Prerequisite(s): ART 1204 or ART 1404 or ART 1414
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2554 - Introduction To Sculpture (3 credits)
Introduction to the tools, techniques, and concepts of sculpture. Development of visual style, three-dimensional composition and communication through iterative assignments. Application of formal analysis and interpretive strategies through critique. Exploration of genres and practices of sculpture by analyzing contemporary examples and historical precedents. Examination of diverse viewpoints through readings and discussions on the role of sculpture in identity, culture, and politics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 1214
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2565 - Typography (3 credits)
Foundational study of Typography as it relates to Visual Communication Design including historical and contemporary context. Study of the formal principles of typographic design of both printed and digital matter. Overall focus on letterforms, design structures, and grid systems. Pre: Admittance to Visual Communication Design Program. 2566: Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. Pre: 2565. 2565: I, II. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2566 - Typography (3 credits)
Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2566H - Typography (3 credits)
Intermediate study of Typography as it relates to Visual Communication Design including advanced file management used with a variety of projects involving Typographic Composition.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2575 - Introduction to Graphic Design (3 credits)
Introduction to the theory and practice of graphic design as a means of visual communication, exploring problem-solving as applied to design concepts and execution. Studio assignments relating to society, industry, community, and commerce, with emphasis on digital/electronic applications. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565
Corequisite(s): ART 1414
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2576 - Introduction to Graphic Design (3 credits)
Introduction to the theory and practice of graphic design as a means of visual communication, exploring problem-solving as applied to design concepts and execution. Studio assignments relating to society, industry, community, and commerce, with emphasis on digital/electronic applications. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2604 - Introduction to Creative Technologies (3 credits)
Introduction to the formal elements, skills, tools and methods of productions used in Creative Technologies to make art/media works. These art works/media works include: sound, video narratives/short films, 2D animation, code/procedural artworks that exhibit meaning and relevance to contemporary society. Integrate, articulate and defend positions on ethical issues to make work that is relevant to the world we live in. Design Lab/Studio.
Prerequisite(s): ART 1604
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2664 - Introduction to Photography (3 credits)
Introduction to the tools, techniques, and concepts of digital photography. Development of visual style, two-dimensional composition, and visual communication through iterative assignments. Application of formal analysis and intercultural interpretation of photographs through class critique as well as historical and contemporary examples. Examination of diverse viewpoints through readings and discussions on the role of photography in identity, culture, and politics. Course contact hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C). (1H, 5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 1204 or ART 1604
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 2704 - 3D Computer Animation (3 credits)
ntroduction to the basic principles of 3d-computer animation including modeling, texture mapping, lighting, and motion. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) RESOURCE CHARGE.
Prerequisite(s): ART 1604
Instructional Contact Hours: (5 Lab, 3 Crd)

ART 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3004 - Topics in Art History (3 credits)
Rotating topics from all periods of art history with a particular emphasis on non-Western art, such as Japanese, Chinese, pre-Columbian, sub-Saharan, Native American, or Islamic art and architecture. Lecture and/or undergraduate seminar format. May be repeated for credit with different content for a maximum of 9 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 3024 - History of Global Print Culture (3 credits)
Global print culture with an emphasis on visual arts and design forms across geographies in cultural contexts. Compares diverse print cultures from their inceptions through today, across historical traditions of East Asia, Mexico, United States, the Islamic world, and Europe. History, social meaning, issues of equity, race, and identity. Print culture's inception through today connects contemporary digital world to its conceptual and material origins.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3034 - Survey of Latin American Art and Architecture (3 credits)
A broad chronological survey of the visual arts and architecture of Latin America with a focus on South, Central, and North America from the rise of ancient indigenous cultures through today. Pre-Columbian iconography, styles, and cultural contexts of Olmec, Inca, Maya, and Aztec societies. European contact and colonial influence in South and Central Americas of the New World. Modern and contemporary art in these regions, with an emphasis on Latinx diaspora visual culture in the United States.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3044 - Art and Architecture of India (3 credits)
Survey of the arts, architecture, and contributions to design history from the subcontinent of India. Iconography and visual elements of Jain, Hindu, Buddhist, Islamic, and Sikh traditions in terms of key works of art, architecture, and design. Interpreted within contexts of religion, historical events, social status, patronage, race, and colonialism. Considers the influence of India's art, architecture, and design histories from antiquity through diasporas today, including US South Asian communities.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3054 - Islamic Art and Architecture (3 credits)
Survey of the visual arts and material culture produced in Islamic cultures from its origins in the 7th century CE (Common Era) through the contemporary period. Focus on analyzing transnational exchanges and influences that shape the visual and material culture of Islamic regions including architecture, the graphic arts, painting, ceramics, and textiles within cultural, geographic, political, and religious contexts. Includes artifacts and architecture from Iraq, Iran, the Arabian Peninsula, Egypt, Turkey, India, Spain and notable sites from North Africa and Central Asia.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3064 - Arts of China and Japan (3 credits)
An introduction to Chinese and Japanese art from the Neolithic to the present. The influence of philosophy, religion and social organizations on the development of the visual arts in China and Japan. Considers a range of media including painting, sculpture, calligraphy, ceramics, prints, and architecture in contexts of Imperial and post-Imperial patronage.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3074 - Egyptian Art and Architecture (3 credits)
Introduction to Egyptian art and architecture from the Predynastic through the Late Period with emphasis on the major monuments of Egyptian sculpture, painting and architecture. Emphasis on Egyptian art in the context of the unique landscape of the Nile River and surrounding desert, the art of contemporary cultures in the eastern Mediterranean world, and the history of archaeological exploration within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3084 - Greek Art and Architecture (3 credits)
Painting, sculpture, and architecture of the Greeks, ca. 1000-31 B.C. Emphasis on correlation of archaeological remains with literary sources, and on the development of the arts in relation to cultural environments of the archaic, classical, and Hellenistic periods.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3114 - Creative Coding for Creativity and Innovation (3 credits)
Introduction to computer programming tools within a critical aesthetic context. Creation and analysis of generative and algorithmic artwork as well as consideration of how works derived from logical rulesets, algorithms, and the artful application of randomness can communicate human feelings and ideas. Consideration of ethics of algorithmic systems in our culture and media, and creating art works to address those issues and influence opinion. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L, 1C), Design Lab/Studio (2L, 1C).
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3174 - Introduction to Archaeology (3 credits)
Introduction to archaeology focusing on a history of the discipline of archaeology with an emphasis on Mesopotamia and the Mediterranean world. Evolution of field inquiry and techniques in the context of major historical personages and excavations in Egypt, Greece, Italy and Syro-Palestine, as well as contemporary global and ethical issues surrounding the preservation and protection of archaeological artifacts, particularly with regards to the role they serve and their use and misuse as non-renewable global objects of cultural heritage and cultural identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3184 - Roman Art and Architecture (3 credits)
Survey of Roman art including painting, sculpture and architecture from ca. 750 BCE to 350 CE. Emphasis on diverse artistic themes connecting visual and material culture with contemporary political and cultural circumstances and the impact of Roman imperial expansion on regional cultures. Historical impact of Roman artistic achievements and activities.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3284 - Medieval Art and Architecture (3 credits)
Artistic traditions of the medieval world from the fourth to fifteenth centuries with a focus on diverse cultural exchanges between Byzantine east and Latin west, along with Islamic contact. Stylistic, thematic, and formal developments in sculpture, painting, textiles, metalwork, architecture, book arts within social, political, and religious contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3384 - Renaissance Art and Architecture (3 credits)
A chronological survey of Renaissance art analyzing painting, sculpture, the graphic arts, and architecture. Develops visual literacy through an evaluation of major stylistic and thematic trends within the study of historical context, artistic techniques and processes, iconography, patronage, economy, religion, political structures, and emerging sciences.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3484 - Baroque and Rococo Art and Architecture (3 credits)
Art and architecture of the seventeenth-century Baroque and eighteenth-century Rococo with with an emphasis on form, style, and cultural contexts for painting, sculpture, and architecture. A study of major artists, themes, styles, and technical artistic processes in Italy, Spain, Flanders, Holland, England, France in contexts of global expansion. Seventeenth-century visual culture in its historical, religious, economic, social, and ethical contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3504 - Topics in Digital Art and Design (3 credits)
Rotating topics that explore the computer as an artistic medium and design tool. Intermediate level. The student will encounter as interdisciplinary approach to the use of the computer, as aesthetic ideas are presented and various digital techniques are applied. Stresses use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated with different content for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C) Resource Charge.
Prerequisite(s): ART 2604
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3514 - Topics In Drawing (3 credits)
Rotating topics in drawing media, approaches, and theories. All topics will be devoted to promoting individual student creativity, mastery of drawing means and techniques, and further understanding of graphic concerns. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). May be repeated for a maximum of 9 hours with different topics. RESOURCE CHARGE.
Prerequisite(s): ART 2514
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 3524 - Topics In Painting Media (3 credits)
Rotating topics in painting techniques, disciplines, and theory emphasizing individual creative development and skilled approaches to technical problem-solving in visual art and design. Intermediate level. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2524
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3554 - Topics In Sculpture (3 credits)
Rotating topics that will focus on specific technical processes and applications of three dimensional problem solving in the visual arts. The course will stress techniques and issues found in contemporary 3D art and design. Emphasizes intensive studio practice through a series of individual projects related to the topics. FEES REQUIRED. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2554
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3564 - Topics in Photography (3 credits)
Rotating topics in photographic materials, methods and philosophies. All topics promote individual students creativity, master of photographic techniques and further understanding of the medium. May be repeated with different topics for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 2664
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3565 - Intermediate Graphic Design I and II (3 credits)
Intermediate design layout, technical and concept development, and communication skills. First semester emphasizes advanced and new software relevant to the design, advertising, and printing industry. Second semester focuses on typography, professional pre-press, electronic printing and color separation processes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3566 - Intermediate Graphic Design II (3 credits)
Intermediate design layout, technical and concept development, and communication skills. First semester emphasizes advanced and new software relevant to the design, advertising, and printing industry. Second semester focuses on typography, professional pre-press, electronic printing and color separation processes. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). FEE REQUIRED.
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 3574 - Topics In Graphic Design (3 credits)
Rotating topics in graphic design, for the intermediate level student. This course will encourage visual problem-solving, conceptual development, clarity and individuality of expression. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2576
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3584 - Nineteenth Century European Art: Neoclassicism to Post-Impressionism (3 credits)
European art and material culture of the nineteenth-century. A chronological study of the major artists, artistic movements and styles from neoclassicism to post-impressionism. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, ethnicity and colonialism in the production of art and material culture.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3604 - Topics in New Media Art (3 credits)
Rotating topics explore the computer as an artistic medium and design tool. An interdisciplinary approach to the use of a computer. Aesthetic ideas and application of digital techniques. Use and manipulation of original images created by the student, employing a combination of digital and traditional methods. May be repeated for a maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 2604
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3674 - History of Photography (3 credits)
A chronological history of photography, from its invention in the nineteenth-century to the emergence of digital technology. Emphasis on historical, sociological, cultural, and global contexts. Addresses terminology and visual analysis, inventions, individual photographers, famous photographs, and issues of inclusion and critical discourse.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3684 - African-American Art (3 credits)
African-American art and material culture, from its beginnings in the tribal traditions of Africa to its contemporary manifestations. A chronological study of the major artists, movements and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3704 - Topics in Computer Animation (3 credits)
Rotating topics that explore the artistic and design potential of computer animation. Using current digital techniques and methods, focus is on the creation and manipulation of virtual character designs. Students will use an interdisciplinary aesthetic approach to investigate computer animation concepts. May be repeated for credit maximum of 12 credits. Course contact to credit hour structure: Design Lab/Studio (5L, 3C). RESOURCE CHARGE.
Prerequisite(s): ART 2704
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 3774 - History of Modern Graphic Design (3 credits)
A chronological survey of the history of modern graphic design, from the mid-19th century to 1980.
Prerequisite(s): ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3784 - European and American Art Since 1900 (3 credits)
European and American Art since 1900. A chronological survey of painting and sculpture from neo-impressionism through post-modernism.
Prerequisite(s): ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3854 - Professional Studio Practices (3 credits)
An overview of professional studio art practices, concepts, marketing strategies and promotional materials. The international exhibition system and current educational opportunities, employment and career options in the visual arts are presented. Preparing of written materials and documenting artwork, building a professional portfolio for presentation to potential employers, art galleries and exhibitions are stressed. Pre: Bachelors of Fine Arts (BFA) majors only.
Prerequisite(s): ART 1504
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3884 - American Art to 1914 (3 credits)
American art and material culture from Pre-Columbian past to the early 20th century. A chronological study of the major artists, artistic movements, and styles. Analysis of works using key critical and philosophical texts. Emphasis on the role of gender, race, and ethnicity in the production of art and material culture.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ART 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3954B - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 3984 - Special Study (19 credits)
Instructional Contact Hours: (19 Lec, 19 Crd)

ART 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCI 4014, HIST 4014

ART 4104 - Interpretation of Visual Arts (3 credits)
Capstone seminar for the Pathways Minor in the Visual Arts and Society. Introduces methodologies, theories, and interpretive strategies commonly used to analyze the visual arts and architecture. Focuses on various critical case studies of global objects and sites ranging from the prehistoric to contemporary periods in the fields of: painting, sculpture, architecture, photography, and film. Assignments explore regional arts resources in these media and develop discursive skills employed in written and oral presentations. Considers ethical and political issues surrounding interpretation of art, as well as attendant epistemological challenges. Pre: Six credits of social sciences from Pathways Minor in the Visual Arts and Society checksheet.
Prerequisite(s): ART 1104
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4184 - Museum Studies: Theory and Practice (3 credits)
Examines the history, theory and practice of museums. Explores the role of the museum in society and traces the foundations upon which these public, cultural, and educational institutions are built. Focus on contemporary museum management, administration, interpretation, collection policy, as well as how museums pertain to historic preservation and public cultural exhibitions.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4284 - Museum Ethics and Cultural Preservation (3 credits)
Advanced art history elective. Role of ethics in institutions that preserve cultural heritage. Practical and philosophical dilemmas and controversies relevant to contemporary problems in cultural preservation. Ethical challenges of governance, acquisition, collecting, audience, copyright, conservation, the politics of display, and censorship, among current topics.
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4384 - Topics in Art History (3 credits)
Advanced art history elective. Rotating topics from all periods of art history, selected to complement offerings at the 3000-level. Topics such as Greek Sculpture, Roman Painting, Renaissance and Baroque Sculpture, Cubism, and Fauvism indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit for a maximum of 18 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 18 credit hours

ART 4484 - Topics in Art Criticism and Methodology (3 credits)
Advanced art history elective. Rotating topics in the criticism of art and the methodology of art history and criticism, selected to complement offerings at the 3000-level. Topics such as the History of Art Criticism from Baudelaire to the Present, New Methods in Renaissance and Baroque Art History, and the Theory of Art from various periods, indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated for credit with different content to a maximum of 9 credits.
Prerequisite(s): ART 2385 or ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 4504 - Topics in Multimedia Studio (3 credits)
This studio course investigates computer-based multimedia in the visual arts and applied design. Video, photography, computer art and design may be used with traditional media and communication vehicles. May be repeated for a maximum of 9 credits. Two 3000-level courses required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 2576 or ART 2604 or ART 3564
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4514 - Interarts Studio (3 credits)
This studio course will investigate new approaches to art-making and new genres, such as performance art and site-specific installation. Interdisciplinary basis for course may incorporate traditional studio practices and media in the visual arts, music and theatre arts, and appropriate technology in computer, video, and film. May be repeated for a maximum of 12 credits with different topics. 3000-level course in Studio or Art History or departmental approval. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 12 credit hours

ART 4524 - Pictorial Arts Studio (3 credits)
Rotating topics in the two dimensional arts, at an advanced level. All topics will challenge the student to develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Painting or Drawing course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3524 or ART 3514
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4534 - Topics in Applied Art and Design Studio (3 credits)
Rotating topics about functional art and design. Students will use appropriate materials, tools, and processes in the creation of functional artworks, such as furniture, tiles, tableware, etc. Function and design aesthetics emphasized. May be repeated for a maximum of 9 credits with different topics. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3544
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4544 - Computer Animation Studio (3 credits)
Advanced animation course focusing on the creation of short films, demo reels, and expressive computer animated films. Students enrolled in this course are expected to complete one large project during the semester. May be repeated with different course content for up to nine credit hours. Course contact to credit hour structure: Design Lab/Studio (5L, 3C)
Prerequisite(s): ART 3704
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4554 - Spatial Arts Studio (3 credits)
Advanced level, rotating topics in the three dimensional arts. All topics will challenge the student to develop stronger, independently generated work of portfolio quality. May be repeated for a maximum of 9 credits with different topics. 3000-level Ceramics, Sculpture or Applied Art course required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE
Prerequisite(s): ART 3554
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

ART 4564 - Exhibition Design And Display (3 credits)
This course will focus on the display and presentation of visual art, for student-designed exhibitions. Provides experience in the public art arena, and practical k arena, and practical knowledge about planning, designing, and mounting an exhibition. Pre: 3000-level Studio or Art History course required.
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4574 - Advanced Visual Communications (3 credits)
A further refinement of design theory and practice, and communication skills. Emphasis on the conceptual development of expanded project formats, and individual creativity. This class will provide a principal opportunity for building a viable portfolio. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C). RESOURCE CHARGE 6 credits of Art 3574 required.
Prerequisite(s): ART 4504
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4575 - Advanced Visual Communication Design (3 credits)
Refinement of design theory, practice, and communication skills. Emphasis placed on methodologies and strategies for developing a personal identity, website, and/or multimedia portfolio. Development of professional brand identity through web design, design of business cards, letterhead, envelopes, and electronic media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565 and ART 3566 and ART 4584
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4576 - Advanced Visual Communication Design (3 credits)
Refinement of design theory, practice, and communication skills. Emphasis placed on methodologies and strategies for developing a personal identity, website, and/or multimedia portfolio. Development of professional brand identity through web design, design of business cards, letterhead, and electronic media. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575 and ART 2576 and ART 3565 and ART 3566 and ART 4584 and ART 4575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4584 - Advanced Typography (3 credits)
Advanced study of Typography as it relates to Visual Communication Design including historical and contemporary context. Terminology and advanced applications of Typography, complex grid systems, experimental typographic methods, and material studies. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Prerequisite(s): ART 1614 and ART 2565 and ART 2566 and ART 2575
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)

ART 4684 - Topics in Museums and Collections (3 credits)
Advanced art history elective. Variable topics related to the study of museums and collections from a global perspective. Topics such as the Natural History Museum, Introduction to Curatorial Studies, Conservation and Collections Management, Race and Colonialism in Museum Exhibitions, and Censorship in Cultural Institutions, indicated by timetable. Lecture and/or undergraduate seminar format. May be repeated 2 times with different content for a maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ART 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4804 - New Media Art Theory (3 credits)
Exploration of new media theory in relationship to contemporary arts practice. Overview and application of new media art aesthetics, strategies, trends, and socio-cultural aspirations. The course will examine theoretical writings and creative work from prevailing technologically-based disciplines.
Prerequisite(s): ART 2385 and ART 2386
Instructional Contact Hours: (3 Lec, 3 Crd)

ART 4894 - Senior Studio (3 credits)
Preparation and presentation of concentrated studio work under faculty supervision, culminating in solo exhibition and/or formal portfolio. May be extended over two semesters with final grade assigned on completion. Or may be repeated for a total of 6 credits at a maximum of 3H, 3C per semester. Senior standing and consent of department head required. Course contact to credit hour structure: Lecture (1H,1C), Lab (3L,1C), Design Lab/Studio (2L,1C).
Instructional Contact Hours: (1 Lec, 5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

ART 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ART 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Art Major with Art History Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
ART 1204	Principles of 2D Art and Design	3
ART 1214	Principles of 3D Art and Design	3
ART 2385	Survey of the History of Western Art	3
Historical Depth		
Select one Art History course from List A		3
Select one of the following:		3
ART 3784	European and American Art Since 1900 [2,3,4]	
ART 3774	History of Modern Graphic Design [4,5]	

Capstone Experience		
Select one of the following:		3
ART 4575	Advanced Visual Communication Design [5]	
ART 4894	Senior Studio [2,3]	
ART 4384	Topics in Art History [4]	
Select one of the following:		3
ART 4576	Advanced Visual Communication Design [5]	
ART 4894	Senior Studio [2,3]	
ART 4384	Topics in Art History (under a different topic) [4,7]	
Subtotal		21
Major Requirements [6]		
ART 4484	Topics in Art Criticism and Methodology	3
Select one course in History [9]		3
Select one course in Religion and Culture from list B below		3
Select twelve credit hours from the following:		12
ART 4184	Museum Studies: Theory and Practice	
ART 4284	Museum Ethics and Cultural Preservation	
ART 4384	Topics in Art History [7]	
ART 4684	Topics in Museums and Collections	
ART 4964	Field Study	
ART 4974	Independent Study	
ART 4994	Undergraduate Research	
Subtotal		21
Restricted Electives [11]		
Select five additonal courses from the below clusters, at least one course from each cluster.		15
Cluster 1		
Select one of the following:		
ART 3074	Egyptian Art and Architecture	
ART 3084	Greek Art and Architecture	
ART 3174	Introduction to Archaeology	
ART 3184	Roman Art and Architecture	
Cluster 2		
Select one of the following:		
ART 3284	Medieval Art and Architecture	
ART 3384	Renaissance Art and Architecture	
ART 3484	Baroque and Rococo Art and Architecture	
Cluster 3		
Select one of the following:		
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	
ART 3684	African-American Art	
ART 3884	American Art to 1914	
ART 3674	History of Photography	
ART 3774	History of Modern Graphic Design	
ART 3784	European and American Art Since 1900	
Cluster 4		
Select one of the following:		
ART 3024	History of Global Print Culture	
ART 3034	Survey of Latin American Art and Architecture	
ART 3044	Art and Architecture of India	
ART 3054	Islamic Art and Architecture	
ART 3064	Arts of China and Japan	
ART 3094		
Subtotal		15
Free Electives		
Select additional courses to fulfill the 120 credit hours required.		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
ART 2386	Survey of the History of Western Art	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) . Pathways 7 may be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours.		3
Subtotal		45
Total Credits		**120**

1. Courses taken to fulfill Core Bachelor of Art requirements cannot also fill Pathways requirements
2. For Creative Technologies majors
3. For Studio majors
4. For Art/Art History majors
5. For Graphic Design majors
6. Students must take no fewer than six of the total required hours from the 4000-level cluster options as Art History designated courses
7. ART 4384 Topics in Art History may not double count as a major and degree core requirement.
8. With permission of the art history program chair
9. May not be HIST 1025 Introduction to European History or HIST 1026 Introduction to European History
10. Students must take no fewer than 9 of the total required hours from the 3000-level cluster options as Art History designated courses

Code	Title	Credits
List A: Art History Courses		
ART 3004	Topics in Art History	
ART 3034	Survey of Latin American Art and Architecture	
ART 3044	Art and Architecture of India	
ART 3054	Islamic Art and Architecture	
ART 3064	Arts of China and Japan	
ART 3074	Egyptian Art and Architecture	
ART 3084	Greek Art and Architecture	
ART 3094		
ART 3174	Introduction to Archaeology	
ART 3184	Roman Art and Architecture	
ART 3284	Medieval Art and Architecture	
ART 3384	Renaissance Art and Architecture	
ART 3484	Baroque and Rococo Art and Architecture	
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	
ART 3674	History of Photography	
ART 3684	African-American Art	
ART 3774	History of Modern Graphic Design	
ART 3784	European and American Art Since 1900	
ART 3884	American Art to 1914	
List B: Religion and Culture Courses		
RLCL 1004	Introduction to Religion and Culture	
RLCL 1024	Judaism, Christianity, and Islam	
RLCL 1034	Religion and the Modern World	
RLCL 1134	The Ancient Mediterranean World	
RLCL 1214	The Medieval World	
RLCL 1904	Religion and Culture In Asia	
RLCL 2444	Greek and Roman Myth	
RLCL 2504	Introduction to American Studies	

GPA Requirements and Progress towards Degree

Students must maintain an overall GPA of 2.0 and an in-major GPA of 2.0. Upon having attempted 72 semester hours (including transfer, AP, advanced standing and credit by exam) an Art History student must have completed at least 6 credits towards this major with a 2.0 overall GPA and have a minimum of a 2.0 in-major GPA. All major requirements and restricted electives count towards the in-major GPA.

Graduation Requirements

Pathways General Education Requirements

Students are responsible for completing the Pathways Education requirements that are in effect when they enter the university. The university requires students to complete course work from all seven areas of the Pathways General Education.

Foreign Language Requirement

Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalogue for details.

Creative Technologies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
ART 1204	Principles of 2D Art and Design	3
ART 1214	Principles of 3D Art and Design	3
ART 2385	Survey of the History of Western Art	3
Historical Depth		
ART 3XXX	Art History course from List A	3
Select one of the following:		3
ART 3784	European and American Art Since 1900 (for Creative Technologies, Studio, and Art/Art History majors)	
ART 3774	History of Modern Graphic Design (for Graphic Design, and Art/Art History majors)	
Capstone Experience		
Select one of the following:		3
ART 4575	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors)	
Select one of the following:		3
ART 4576	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors; under a different topic)	
Subtotal		21
Major Requirements		
ART 1604	Principles of 4D Art & Design	3
ART 2604	Introduction to Creative Technologies	3
ART 2704	3D Computer Animation	3
ART 3504	Topics in Digital Art and Design	3
ART 3604	Topics in New Media Art	3
ART 3704	Topics in Computer Animation	3
ART 3854	Professional Studio Practices	3
ART 4804	New Media Art Theory	3
Subtotal		24
Restricted Electives		
ART 2XXX	ART Elective (2000-level course required from list B below)	3
ART XXXX	ART Elective (2000/3000/4000-level course required from list B/C below)	3
ART XXXX	ART Elective (3000/4000 level course chosen from list C below)	3
ART XXXX	ART Elective (3000/4000 level course chosen from list C below)	3

ART XXXX	ART Elective (3000/4000 level course chosen from list C below)	3
ART XXXX	ART Elective (3000/4000 level course chosen from list C below)	3
ART XXXX	ART Elective (3000/4000 level course chosen from list C below)	3
Subtotal		21
Free Electives		
Select remaining credits to equal 120		9
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select two courses in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select one course in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
ART 2386	Survey of the History of Western Art	3
Select one additional course in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select two courses in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select two courses in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
ART 2434	Introduction to Creative Code (5F)	3
Select one course in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select one additional course in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
ART 1504	Contemporary Art and Practice (6A)	3
ART 1404	Principles of Drawing (6D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select from approved courses, 3 credits may be double-counted with another core concept		3
Subtotal		45
Total Credits		**120**

[1] Courses taken to fulfill Core Bachelor of Art requirements cannot also fill Pathways requirements

Approved Elective Courses

List A: Art History Courses

Code	Title	Credits
ART 3004	Topics in Art History	3
ART 3024	History of Global Print Culture	3
ART 3034	Survey of Latin American Art and Architecture	3
ART 3044	Art and Architecture of India	3
ART 3054	Islamic Art and Architecture	3
ART 3064	Arts of China and Japan	3
ART 3074	Egyptian Art and Architecture	3
ART 3084	Greek Art and Architecture	3
ART 3094		3
ART 3174	Introduction to Archaeology	3
ART 3184	Roman Art and Architecture	3
ART 3284	Medieval Art and Architecture	3
ART 3384	Renaissance Art and Architecture	3
ART 3484	Baroque and Rococo Art and Architecture	3
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	3
ART 3674	History of Photography	3
ART 3684	African-American Art	3
ART 3884	American Art to 1914	3

List B: 2XXX ART Elective Course Options

(3-6 credits)

Code	Title	Credits
ART 2514	Drawing Concepts	3
ART 2524	Introduction To Painting	3
ART 2554	Introduction To Sculpture	3
ART 2664	Introduction to Photography	3

List C: 3XXX/4XXX ART Elective Course Options

(15-18 credits)

Code	Title	Credits
ART 3504	Topics in Digital Art and Design	3
ART 3514	Topics In Drawing	3
ART 3524	Topics In Painting Media	3
ART 3554	Topics In Sculpture	3
ART 3564	Topics in Photography	3
ART 3604	Topics in New Media Art	3
ART 3704	Topics in Computer Animation	3
ART 3954	Study Abroad With permission of Creative Technologies Chair	1-19
ART 4504	Topics in Multimedia Studio	3
ART 4514	Interarts Studio	3
ART 4524	Pictorial Arts Studio	3
ART 4534	Topics in Applied Art and Design Studio	3
ART 4544	Computer Animation Studio	3
ART 4554	Spatial Arts Studio	3
ART 4564	Exhibition Design And Display	3
ART 4974	Independent Study With permission of Creative Technologies Chair	1-19
ART 4994	Undergraduate Research With permission of Creative Technologies Chair	1-19

Satisfactory Progress Toward Degree

The University requires every department to establish benchmarks by which their majors can demonstrate that they are making satisfactory progress toward a degree. In addition to the University requirement for satisfactory progress (See Satisfactory Progress in Academics chapter

of Undergraduate Catalogue), in the case of the Creative Technologies major, these benchmarks are:

1. Students must earn a C- or better in required Foundations courses (ART 1204 Principles of 2D Art and Design, ART 1214 Principles of 3D Art and Design, ART 1404 Principles of Drawing, ART 1504 Contemporary Art and Practice, ART 1604 Principles of 4D Art & Design).
2. Upon having attempted 72 semester hours (including transfer, AP, advanced standing and credit by exam) an Art student must have completed at least 6 credits towards this major with a 2.0 overall GPA and have a minimum 2.0 in-major GPA.
3. Students must successfully complete their BFA exhibition (ART 4894 Senior Studio).

Prerequisites

This check sheet contains elective courses that may have prerequisites not listed on this checksheet. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Graduation Requirements

Pathways General Education Requirements

Students are responsible for completing the Pathways General Education requirements that are in effect when they enter the university. The university requires students to complete course work from all seven areas of the Curriculum for Pathways General Education Curriculum for Liberal Education.

GPA Requirements

Students must maintain a 2.0 GPA. In-major GPA requires a grade of C- or better to successfully complete an ART course. In-major GPA is calculated on all ART courses.

Foreign Language Requirement

Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign language or classical language at the college level. Such semester hours are in addition to those normally required for graduation. Please see the undergraduate catalog for details.

Graphic Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
ART 1204	Principles of 2D Art and Design	3
ART 1214	Principles of 3D Art and Design	3
ART 2385	Survey of the History of Western Art	3
Historical Depth		
ART 3XXX	Art History course from List A	3
Select one of the following:		3
ART 3784	European and American Art Since 1900 (for Creative Technologies, Studio, and Art/Art History majors)	
ART 3774	History of Modern Graphic Design (for Graphic Design, and Art/Art History majors)	
Capstone Experience		
Select one of the following:		3
ART 4575	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors)	
Select one of the following:		3
ART 4576	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors; under a different topic)	
Subtotal		21
Major Requirements		
ART 1614	Principles of Visual Communication Design	3
ART 2565	Typography (Graphic Design majors only)	3
ART 2566	Typography	3
ART 2575	Introduction to Graphic Design	3
ART 2576	Introduction to Graphic Design	3
ART 3565	Intermediate Graphic Design I and II	3
ART 3566	Intermediate Graphic Design II	3
ART 3900	Bridge Experience	0
ART 4584	Advanced Typography	3
Subtotal		24
Restricted Electives		
ART XXXX	Graphic Design Elective from list D below	3
ART XXXX	Graphic Design Elective from list D below	3
ART XXXX	Graphic Design Elective from list D below	3
ART XXXX	Graphic Design Elective from list D below	3
ART XXXX	Art Elective from list B	3
ART XXXX	Art Elective from list B or C below	3
Subtotal		18
Free Electives		
Select remaining credits to equal 120		12
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select 6 hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select 3 hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
ART 2386	Survey of the History of Western Art	3
Select one additional course in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		

Select 6 hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select 3 hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select 3 hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select 3 hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) OR Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
ART 1404	Principles of Drawing (6A)	3
ART 1604	Principles of 4D Art & Design (6D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
3 credits may be double-counted with another core concept		3
Subtotal		45
Total Credits		**120**

[1] Courses taken to fulfill Core Bachelor of Art requirements cannot also fill Pathways requirements

Approved Elective Courses

List A: Art History Elective Course Options

(3 credits)

Code	Title	Credits
ART 3004	Topics in Art History	3
ART 3024	History of Global Print Culture	3
ART 3034	Survey of Latin American Art and Architecture	3
ART 3044	Art and Architecture of India	3
ART 3054	Islamic Art and Architecture	3
ART 3064	Arts of China and Japan	3
ART 3074	Egyptian Art and Architecture	3
ART 3084	Greek Art and Architecture	3
ART 3094		3
ART 3174	Introduction to Archaeology	3
ART 3184	Roman Art and Architecture	3
ART 3284	Medieval Art and Architecture	3
ART 3384	Renaissance Art and Architecture	3
ART 3484	Baroque and Rococo Art and Architecture	3
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	3
ART 3674	History of Photography	3
ART 3684	African-American Art	3
ART 3884	American Art to 1914	3

List B: 2XXX ART Elective Course Options

(3-6 credits)

Code	Title	Credits
ART 2514	Drawing Concepts	3
ART 2524	Introduction To Painting	3
ART 2554	Introduction To Sculpture	3
ART 2604	Introduction to Creative Technologies	3
ART 2664	Introduction to Photography	3
ART 2704	3D Computer Animation	3

List C: 3XXX/4XXX ART Elective Course Options

(0-3 credits)

Code	Title	Credits
ART 3504	Topics in Digital Art and Design	3
ART 3514	Topics In Drawing	3
ART 3524	Topics In Painting Media	3
ART 3554	Topics In Sculpture	3
ART 3564	Topics in Photography	3
ART 3574	Topics In Graphic Design	3
ART 3604	Topics in New Media Art	3
ART 3704	Topics in Computer Animation	3
ART 4504	Topics in Multimedia Studio	3
ART 4514	Interarts Studio	3
ART 4524	Pictorial Arts Studio	3
ART 4534	Topics in Applied Art and Design Studio	3
ART 4544	Computer Animation Studio	3
ART 4554	Spatial Arts Studio	3
ART 4564	Exhibition Design And Display	3
ART 4804	New Media Art Theory	3

List D: 3XXX/4XXX Graphic Design Electives

Code	Title	Credits
ART 3574	Topics In Graphic Design	3
ART 3954	Study Abroad With approval from Graphic Design program chair	1-19
ART 4504	Topics in Multimedia Studio	3
ART 4754	Internship With approval from Graphic Design program chair	1-19
ART 4964	Field Study With approval from Graphic Design program chair	1-19
ART 4974	Independent Study With approval from Graphic Design program chair	1-19
ART 4994	Undergraduate Research With approval from Graphic Design program chair	1-19

Satisfactory Progress Toward Degree

The University requires every department to establish benchmarks by which their majors can demonstrate that they are making satisfactory progress toward a degree. In addition to the University requirement for satisfactory progress (See Satisfactory Progress in Academics chapter of Undergraduate Catalogue), in the case of the Graphic Design major, these benchmarks are:

1. Students must maintain a C- or better in required Foundations courses (ART 1204 Principles of 2D Art and Design,ART 1214 Principles of 3D Art and Design , ART 1404 Principles of Drawing, ART 1604 Principles of 4D Art & Design).
2. Upon having attempted 72 semester hours (including transfer, AP, advanced standing and credit by exam) an Art student must have completed at least 6 credits towards this major with a 2.0 overall GPA and have a minimum 2.0 in-major GPA.
3. Students must successfully complete their BFA exhibition (ART 4576 Advanced Visual Communication Design).

Prerequisites

This check sheet contains elective courses that may have prerequisites not listed on this checksheet. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Graduation Requirements

Pathways General Education Requirements

Students are responsible for completing the Pathways General Education requirements that are in effect when they enter the university. The university requires students to complete course work from all seven areas of the Curriculum for Pathways General Education.

GPA Requirements

Students must maintain a 2.0 GPA. In-major GPA requires a grade of C- or better to successfully complete an ART course. In-major GPA is calculated on all ART courses.

Foreign Language Requirement

Students who do not successfully complete at least two units of a single foreign language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign language or classical language at the college level. These semester hours are in addition to those normally required for graduation. Please see the course catalog for details.

Studio Art Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
ART 1204	Principles of 2D Art and Design	3
ART 1214	Principles of 3D Art and Design	3
ART 2385	Survey of the History of Western Art	3
Historical Depth		
ART 3XXX	Art History course from List A	3
Select one of the following:		3
ART 3784	European and American Art Since 1900 (for Creative Technologies, Studio, and Art/Art History majors)	
ART 3774	History of Modern Graphic Design (for Graphic Design, and Art/Art History majors)	
Capstone Experience		
Select one of the following:		3
ART 4575	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors)	
Select one of the following:		3
ART 4576	Advanced Visual Communication Design (Graphic Design majors)	
ART 4894	Senior Studio (CT and Studio majors; must have senior standing in Studio or CT)	
ART 4384	Topics in Art History (Art/Art History majors; under a different topic)	
Subtotal		21
Major Requirements		
ART 1604	Principles of 4D Art & Design	3
ART 2514	Drawing Concepts	3
ART 2524	Introduction To Painting	3
ART 2554	Introduction To Sculpture	3
ART 2664	Introduction to Photography	3
ART 3854	Professional Studio Practices	3
ART 4564	Exhibition Design And Display	3
Subtotal		21
Restricted Electives		
ART 2XXX	Art Elective (2000-level course required from list B below)	3
ART 3XXX	Art Elective (3000-level course required from list C below)	3
ART 3XXX	Art Elective (3000-level course required from list C below)	3
ART 3XXX	Art Elective (3000-level course required from list C below)	3
ART 3XXX	Art Elective (3000-level course required from list C below)	3
ART 4XXX	Art Elective (4000-level course required form list D below)	3
ART 4XXX	Art Elective (4000-level course required form list D below)	3
ART XXXX	Art Elective (Any 2000-4000 level course from list B, C or D below)	3
Subtotal		24
Free Electives		
Select remaining credits to equal 120		9
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select 6 hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select 3 hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
ART 2386	Survey of the History of Western Art	3
Select one additional course in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select 3 hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select 3 hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3

Select 3 hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
ART 1504	Contemporary Art and Practice (6A)	3
ART 1404	Principles of Drawing (6D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
3 credits may be double-counted with another core concept		3
Subtotal		45
Total Credits		**120**

[1] Courses taken to fulfill Core Bachelor of Art requirements cannot also fill Pathways requirements

Approved Elective Courses

List A: Art History Elective Course Options

Code	Title	Credits
ART 3004	Topics in Art History	3
ART 3024	History of Global Print Culture	3
ART 3034	Survey of Latin American Art and Architecture	3
ART 3044	Art and Architecture of India	3
ART 3054	Islamic Art and Architecture	3
ART 3064	Arts of China and Japan	3
ART 3074	Egyptian Art and Architecture	3
ART 3084	Greek Art and Architecture	3
ART 3094		3
ART 3174	Introduction to Archaeology	3
ART 3184	Roman Art and Architecture	3
ART 3284	Medieval Art and Architecture	3
ART 3384	Renaissance Art and Architecture	3
ART 3484	Baroque and Rococo Art and Architecture	3
ART 3584	Nineteenth Century European Art: Neoclassicism to Post-Impressionism	3
ART 3674	History of Photography	3
ART 3684	African-American Art	3
ART 3884	American Art to 1914	3

List B: 2XXX Art Elective Course Options

(3 credits)

Code	Title	Credits
ART 2604	Introduction to Creative Technologies	3
ART 2704	3D Computer Animation	3

List C: 3XXX Art Elective Course Options

(12 credits)

Code	Title	Credits
ART 3504	Topics in Digital Art and Design	3
ART 3514	Topics In Drawing	3
ART 3524	Topics In Painting Media	3
ART 3554	Topics In Sculpture	3
ART 3564	Topics in Photography	3
ART 3604	Topics in New Media Art	3
ART 3704	Topics in Computer Animation	3

List D: 4XXX Studio Art Elective Course Options

(6 credits)

Code	Title	Credits
ART 3954	Study Abroad With permission of Studio Art Chair	1-19
ART 4504	Topics in Multimedia Studio	3
ART 4514	Interarts Studio	3
ART 4524	Pictorial Arts Studio	3
ART 4554	Spatial Arts Studio	3
ART 4804	New Media Art Theory	3
ART 4964	Field Study With permission of Studio Art Chair	1-19
ART 4974	Independent Study With permission of Studio Art Chair	1-19
ART 4994	Undergraduate Research With permission of Studio Art Chair	1-19

Satisfactory Progress Toward Degree

The University requires every department to establish benchmarks by which their majors can demonstrate that they are making satisfactory progress toward a degree. In addition to the University requirement for satisfactory progress (See Satisfactory Progress in Academics chapter of Undergraduate Catalogue), in the case of the Studio Art major, these benchmarks are:

1. Students must maintain a C- or better in required Foundations courses (ART 1204 Principles of 2D Art and Design, ART 1214 Principles of 3D Art and Design, ART 1404 Principles of Drawing, ART 1504 Contemporary Art and Practice, ART 1604 Principles of 4D Art & Design).
2. Upon having attempted 72 semester hours (including transfer, AP, advanced standing and credit by exam) a Studio Art student must have completed at least 6 credits towards this major with a 2.0 overall GPA and have a minimum 2.0 in-major GPA.
3. Students must successfully complete their BFA exhibition (ART 4894 Senior Studio).

Graduation Requirements

Pathways General Education

Students are responsible for completing the Pathways Education requirements that are in effect when they enter the university. The university requires students to complete course work from all seven areas of the Pathways General Education.

GPA Requirements

Students must maintain a 2.0 GPA. In-major GPA requires a grade of C- or better to successfully complete an ART course. In-major GPA is calculated on all ART courses.

Foreign Language Requirement

Students who do not successfully complete at least two units of a single language, classical language or American Sign Language during high school must successfully complete six semester hours of a single college level foreign language or classical language at the college level. Such

semester hours are in addition to those normally required for graduation. Please see the undergraduate catalogue for details.

Theatre and Cinema

Our Website (http://www.performingarts.vt.edu)

Overview

The curriculum in Theatre and Cinema is designed to provide the student with the essential approaches necessary to develop an informed understanding of Theatre and Cinema literature and its practice. As such, the three basic aspects of the disciplines (the theoretical, the historical, and the practical) are emphasized.

A program in Theatre Arts leading to the B.A. is offered. In addition to fulfilling the core curriculum requirements of the College of Architecture, Arts, and Design and the Curriculum for Liberal Education, general majors who choose the general degree option must complete a minimum of 48 hours in theatre arts. Students who choose a degree option in Performance, Design, or a Cinema major, must complete a minimum of 57 hours.

A minor course of study in Theatre or Cinema may be chosen with the guidance of the student's advisor.

Limited scholarship support is available.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in Theatre Arts.

Satisfactory progress requirements toward the B.A. in Theatre Arts can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Cinema Major (p. 652)
- Theatre Arts Major with Design Option (p. 653)
- Theatre Arts Major with General Theatre Option (p. 654)
- Theatre Arts Major with Performance Option (p. 655)

Director, School of Performing Arts | Music | Theatre | Cinema: J. Loeffert
Faculty Chair: J. Ambrosone
Professors: R. H. Leonard, P. Raun[3], and B. Lepczyk[2,3,6]
Associate Professors: J. Ambrosone, G.S. Hardwig, G. W. Justice[7,10], A. Nelson, C. Rawlings, S. C. Rinehart[8,10], N. Staley, and C. Dye
Assistant Professors: J. Catherwood-Ginn, K. Chipman, L. Dandridge, B. Harris, J. Perkinson, and L. Iancu
Visiting Assistant Professors: D. Gammons
Senior Instructors: K. Precoda[10]

Instructors: J. Brewer and W. A. Sanders
A.P. Faculty: S. Blackburn
Assistant Professors of Practice: T. Holland
Visiting Assistant Professors of Practice: N. Benavides

Career Advisors: All faculty
Emeritus Professors: B. Dukore, D.W. Johnson, P. Lavender, F.N. Proctor, and R.W. Ward

1 Award for Excellence in Undergraduate Advising
2 Academy of Teaching Excellence inductee
3 Wine Award recipient
4 Sporn Award recipient
5 Alumni Award for Extension Excellence
6 Alumni Award for Research Excellence
7 Alumni Award for Teaching Excellence
8 Academy of Faculty Service
9 Commonwealth of Virginia Outstanding Faculty Award
10 Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (CINE)

CINE 2054 - Introduction to Cinema (3 credits)
Introduction to cinema as a medium for artistic communication. Interpretation and analysis of films to understand designs, ideas and values in artistic and cultural contexts. Basic elements of cinema structure and cinema terminology, phases of cinema production, cinema style of individual directors, creative work of cinematography, production design, and editing, ideological and social meaning in cinema, demographics of visual representation, cinemas economic marketplace. Ethical values and conflicts as found in given films, and ethical reasoning as part of the analysis of cinema.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CINE 2064 - Introduction to Cinema Production (3 credits)
Introductory filmmaking course. Thematic conception and story construction, writing, producing, directing, cinematography, sound recording, and editing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3184 - Cinema Production Topics (1-9 credits)
Rotating topics in cinema production. Designed for majors in the Department of Theatre and Cinema who have foundational training in areas of cinema production. May be repeated for credit with different course content up to a maximum of nine credit hours.
Prerequisite(s): CINE 3214 or CINE 3224
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

CINE 3214 - Fiction Cinema Production (3 credits)
Intermediate-level fiction film production course. Foundational cinema production skills, dramatic storytelling techniques, intermediate directing, team- based ownership and responsibility, and project management.
Prerequisite(s): CINE 2054 and CINE 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3224 - Documentary Cinema Production (3 credits)
Intermediate-level, non-fiction, film production course for students seeking non-fiction documentary film production skills and experience. Emphasizes the application and advancement of foundational skills, the ethics of documentary filmmaking, story development and project management.
Prerequisite(s): CINE 2054 and CINE 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3444 - African American Images in Film (3 credits)
Explores race and representations of African American images in film, from multiple disciplinary perspectives. Focuses on the social, political, economic, and historical milieu in which black film emerged and evolved. Examines gender issues in filmmaking. Reviews different genres, including race films, colorblind representations, and black exploitation films, and the appropriation of black representation and black images in film in the United States and elsewhere. Includes methods of film analysis, such as historical, master narrative structure, and archival research.
Prerequisite(s): AFST 1714
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 3444

CINE 3514 - American Cinema Genres (3 credits)
Close visual and cultural study of classic film genres with emphasis on cinematic styles and narrative conventions which unify the genre and which are found in representative films; exploration of genre films as symbols of American culture and society. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 3524 - The Cinema Director (3 credits)
Close thematic and visual analysis of the films of prominent cinema directors; emphasis on cinematic structure and development and evolution of their work. Specific thematic content is variable. Course may be repeated with different course content for up to 9 credits.
Prerequisite(s): TA 2054 or CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 3534 - Avant-Garde Cinema (3 credits)
Close visual and cultural study of the avant-garde and experimental tradition in the first half-century of American and European cinemas; emphasis on interrelations of cinema with avant-garde movements in other arts, including literature, music, dance, theatre, painting, and photography
Prerequisite(s): CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)

CINE 3544 - Literature and Cinema (3 credits)
Works of literature and the films into which they have been transformed; emphasis on differences between media.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3544

CINE 4084 - Cinema History (3 credits)
Aesthetic, economic, social and technological history of world cinema; film theory as it relates to the history of cinema. Junior standing required.
Prerequisite(s): CINE 2054
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CINE 4144 - Topics in Cinema Studies (3 credits)
Critical issues in cinema. Aesthetic, social, political, and economic contexts for films that embody or critique assumptions of historical periods. Analysis of ethnocentric and cultural biases in cinema. Identifying issues of identity and equity in films. Theories and ethics of representation. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): CINE 2054
Pathway Concept Area(s): 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CINE 4534 - Underground Cinema and Culture (3 credits)
Close visual and cultural study of underground cinema and culture from the 1940s through the 1970s; emphasizes the interrelations of cinema with countercultural movements in other arts, including literature, music, dance, theatre, painting, and photography; focuses on the post-war avant-garde, the emergence of film societies, the neorealist and new wave cinemas, challenges to censorship laws, and the emergence of cult and midnight movies.
Prerequisite(s): CINE 2054
Instructional Contact Hours: (3 Lec, 3 Crd)

Undergraduate Course Descriptions (DANC)

DANC 2004 - Anatomy for Performers (3 credits)
An experiential course merging the artistic, experiential, and conceptual understanding of the human body, and how all of its elements work together to produce motion and the sense of being. Study of the anatomical structures of the body through an experiential lens of motion and sensory perception. Introduction of the concepts of kinesiology through the study of bone, joint, tissue, muscular, and organ structures. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to practices of equitable embodied identity. Lecture, demonstration, and experience-based partnering work that draw from a variety of somatic traditions including yoga, pilates, Body-Mind Centering, release technique, Alexander and Feldenkrais techniques, Gyrotonic/Gyrokinesis, and mediation. Designed for performers in the arts, athletes, martial artists, or any students wishing to study the body from an experiential lens.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

DANC 2014 - Introduction to Dance History (3 credits)
Survey of dance history as an art form with global scope. Language of dance criticism and dance writing practices. International dance forms and the emergence and development of 20th and 21st century modern and post-modern concert dance in the United States from the confluence of European folk and court dances, ballet, African and Caribbean influences, and other American cultural dynamics. Emphasis on ethical and aesthetic modes of viewing dance performance with attention to issues of gender and sexuality, race and ethnicity, ability, class, and identity.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

DANC 2024 - Introduction to Dance Techniques (3 credits)
Beginner-level studio dance course. Introduction of movement techniques, improvisation/composition, performance, experiential anatomy, and an overview to concepts in dance history. Development of flexibility, strength, coordination, rhythm, and vocabulary in the modern idiom. Concepts of time, space, energy, and choreographic form presented through set movement exercises, improvisation, and a final compositional project. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. May be repeated once with different content for a maximum of 6 credits. Design Lab/Studio.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

DANC 2104 - Moving Body, Moving Mind (3 credits)
Methods of working intentionally towards cultivating optimal brain states. Mind/body practices to develop connections between contemporary neuroscience, movement, and meditative practices. Studies in the intersection of consciousness, movement, and thought. Introduction to yoga, meditation, authentic movement, experiential anatomy, and somatic work. Emphasis on holistic perspectives of the body through active listening, ethical reasoning, healthy self-image, and attention to the practices of intentional embodiment.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2104

DANC 3024 - Intermediate/Advanced Dance Techniques (3 credits)
Intermediate/advanced level course in movement techniques. Training in a variety of movement vocabularies including modern/contemporary, ballet, and cultural dance forms. Improvisation/composition, performance, concepts in anatomy/kinesiology, and 21st century contemporary dance forms. Development of flexibility, strength, coordination, rhythm, vocabulary in the modern idiom, and focused study of partnering concepts from a variety of hybrid forms. Concepts of time, space, energy, and choreographic form presented through set movement exercises and two compositional projects. May be repeated 3 times with different content for a maximum of 9 credits. Design/Lab Studio.
Prerequisite(s): DANC 2024
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 9 credit hours

Undergraduate Course Descriptions (FA)

FA 2004 - Creativity and the Artistic Experience (3 credits)
Examine how the arts intersect with our daily lives. Compose and create basic examples of abstraction and 20th century modernism. Trace the global influences and roots of our current culture. Explore the science of acoustics and its effect on performing spaces. Discuss the process of an arts performance. Apply themes of improvisation, creativity and how we process beauty. Investigate emerging brain science as it relates to art, beauty and pleasure. Identify the unique ways of knowing embodied in the arts distinct from scientific measurements. No prior knowledge of visual, theatrical or musical arts needed.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

Undergraduate Course Descriptions (TA)

TA 1004 - School of Performing Arts First Year Experience (1 credit)
Orientation to the School of Performing Arts philosophy and the resources of the School, the College, and the University. Cultivate a common intellectual, analytical, and creative conversation among first-year students. Enhance student participation in the creative and scholarly life of the Schools programs. Foster a sense of community and understanding across disciplines.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: MUS 1004

TA 2014 - Introduction to Theatre (3 credits)
Appreciation and understanding of theatre as a living, collaborative art form through historical and intercultural perspectives, readings of key texts and analysis of scripts, and explorations of all elements of the theater making process, including playwriting, directing, acting, and design.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2024 - Introduction to Acting (3 credits)
Introductory performance class in acting skills and theories as a participant (actor) and observer (audience) for the non-major. Includes performances of dramatic literature/ improvisation for live audience, creating character biography and script analysis, historical and intercultural contexts, and techniques in constructive criticism that incorporate interpretive strategies.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2044 - Contemporary African American Theatre (3 credits)
Contributions of U.S. Black theatre artists; intersectional identities; performances spaces and society; critical race theory; dramatic storytelling; cultural behaviors; racial discrimination.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2044, ENGL 2044

TA 2104 - Fundamentals of Theatre and Production (3 credits)
Introduction to theatre vocabulary and understanding of the theatrical process, theatre aesthetics, theatrical modes of expression, basic script analysis, production analysis, theory and practice of collaboration, theatre organizations, history and operations of professional theatres. (T & C majors and minors only).
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2114 - Script Analysis (3 credits)
Understanding of drama as an element of theatre with focus on the process of script analysis for theatrical production.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2134 - Acting Lab (3 credits)
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on improvisation, terminology, physical action, script analysis, characterization, and rehearsal and performance techniques. Limited to Theatre & Cinema Majors.
Instructional Contact Hours: (6 Lab, 3 Crd)

TA 2144 - Foundations of Movement and Voice (3 credits)
An introduction to the process of acting, through a variety of laboratory experiences, beginning with basic performance skills and culminating in the performance experience. Emphasis is on various methods of performance style and analysis, theater movement and body conditioning, and vocal awareness and production. Limited to Theatre & Cinema Majors.
Prerequisite(s): TA 2134
Instructional Contact Hours: (6 Lab, 3 Crd)

TA 2164 - Scene Design Lab (3 credits)
An introduction to the processes, technologies, and aesthetics of scene design for theatrical productions and analysis of playscripts. Students develop workshop drawing, conceptual design and vision, and collaborative skills related to scene design, and exploration is focused in historical and contemporary theatre practice. A range of design problems will offer opportunity to learn various design approaches and provide practice with different media and means of design expression. Design Lab.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

TA 2174 - Costume Design Lab (3 credits)
Introduction to the processes, technologies, and aesthetics of costume design for theatrical productions and analysis of playscripts. Focus on developing workshop drawings, conceptual design and vision, and collaborative skills related to costume design, with special emphasis on historical and contemporary theatre practice. Various design approaches, different media, and a range of design problems are introduced. Design Lab/Studio.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

TA 2204 - Creative Dance (3 credits)
Study of the expressive elements of movement and dance. Basic choreographic procedures and small group work to design dances that emphasize particular movement concepts. Experience in music and movement of diverse dance cultures. Documentation of the pathways of dances in floorplans and written reflections on the creative processes.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2224 - Intermediate Performance Intensive (3 credits)
This course provides the Theatre & Cinema major, who desires a rigorous exploration of acting, a forum for application of the techniques and skills learned. These skills will be strengthened and applied through observation of and participation in scene and monologue work. Focus will be placed on basic skills and concepts necessary to creative, truthful, and believable performance of selected scenes, including use of voice and body, imagination, relaxation, sense and emotion memory, and script analysis. Limited to Theatre & Cinema Majors.
Prerequisite(s): TA 2134 and TA 2144
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2404 - Introduction to Applied Collaborative Techniques (3 credits)
Introduction to principles of collaboration in applied theatre for non-majors. Situational awareness, intrapersonal and interpersonal awareness, audience engagement, effective storytelling, team creativity and conflict resolution, and communicating across difference in public and professional settings.
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2414 - Stage and Lighting Technology (3 credits)
A practical study of the technologies and specialized equipment employed in the construction, rigging and running of theatrical production; the planning and organization involved in mounting these productions; the tools, materials and techniques used to realize theatrical design and build scenery; and the fundamentals of stage lighting.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 2604 - Introduction to Arts Marketing (3 credits)
An introduction to the theories and practice of marketing and building community engagement as applied to arts activities and professional not-for-profit arts organizations, through a survey of standard marketing approaches, examination of current practices in the field, and direct hands-on experience.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MUS 2604

TA 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

TA 2984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 3014 - Theatre Production Lab (1-3 credits)
Production experiences in the areas of performance, design and theatre technology, management, and writing. May be repeated for a maximum of nine credits.
Instructional Contact Hours: (1-3 Lab, 1-3 Crd)
Repeatability: up to 9 credit hours

TA 3024 - Intermediate Acting for Non-Theatre Major (3 credits)
Performance class in acting skills, theories, and genres. Designed for non-theatre arts majors. Builds on fundamentals and theory learned in Introduction to Acting. Includes body and voice awareness, performance of specific genres, and expanded acting theory and analysis.
Prerequisite(s): TA 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3104 - Sound Technology Topics (3-6 credits)
Rotating topics in theatre sound technology and sound design. Designed for advanced theatre arts and cinema majors who have foundational training in areas of theatre technology and design. May be repeated 2 times with different content for a maximum of 9 credit hours. Design Lab.
Prerequisite(s): TA 2414
Instructional Contact Hours: (1 Lec, 3-8 Lab, 3-6 Crd)
Repeatability: up to 9 credit hours

TA 3105 - History of Drama and Theatre (3 credits)
History of drama and theatre from primitive ritual to the present day and its relationship to the social, economic, and political forces from age to age. 3105: primitive, Greek, Roman, Medieval, Renaissance, and Asian. 3106: Restoration, eighteenth, nineteenth, and twentieth centuries. Junior standing required.
Prerequisite(s): TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3106 - History of Drama and Theatre (3 credits)
History of drama and theatre from primitive ritual to the present day and its relationship to the social, economic, and political forces from age to age. 3105: primitive, Greek, Roman, Medieval, Renaissance, and Asian. 3106: Restoration, eighteenth, nineteenth, and twentieth centuries.
Prerequisite(s): TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3114 - Scenography Topics (9 credits)
Rotating topics in scenography and related specific design applications. Designed for theatre arts majors who have foundational training in areas of theatre design. May be repeated for credit.
Prerequisite(s): TA 2164
Instructional Contact Hours: (9 Lec, 9 Lab, 9 Crd)
Repeatability: up to 9 credit hours

TA 3124 - Costume Design and Technology Topics (1-9 credits)
Rotating topics of costume design and costume technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre design. May be repeated for credit.
Prerequisite(s): TA 2174
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

TA 3134 - Lighting Topics (1-9 credits)
Rotating topics in lighting design and technology. Designed for advanced theatre arts majors who have foundational training in all areas of theatre arts. May be repeated for credit. (Variable credit)
Prerequisite(s): TA 2414
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

TA 3144 - Theatre Technology Topics (9 credits)
Rotating topics in design and theatre technology. Designed for advanced theatre arts majors who have foundational training in all areas if theatre technology and design. May be repeated for unlimited number of credit hours.
Prerequisite(s): TA 2414
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3154 - Acting Topics (9 credits)
Rotating topics in performance skills and theories. Designed For advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit.
Prerequisite(s): TA 2224 and TA 2144
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3164 - Voice and Speech Topics (9 credits)
Rotating topics in voice and speech skills, and theories and practice in performance. Designed for advanced theatre arts majors who have foundational training in acting, voice and movement. May be repeated for credit.
Prerequisite(s): TA 2224 and TA 2144
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3174 - Movement Topics (9 credits)
Rotating topics in theatre movement, dance for the theatre and theories of physical expression in the performing arts. Designed for advanced theatre arts majors who have foundational training in acting voice and movement. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): TA 2144 and TA 2224
Instructional Contact Hours: (9 Lec, 9 Crd)
Repeatability: up to 9 credit hours

TA 3315 - Playwriting (3 credits)
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3315

TA 3604 - Arts Management (3 credits)
The development of the not-for-profit arts organization, structures and characteristics of boards of directors, artistic missions and goals, funding, volunteer support, and fiscal control. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3624 - Stage Management (3 credits)
The systems, procedures, forms, and duties of the stage manager in the professional, academic, and community theatre are explored in relationship to the production process and other theatre artists.
Prerequisite(s): TA 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 3954F - Study Abroad (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design
Instructional Contact Hours: Variable credit course

TA 3954M - Study Abroad (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 3984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

TA 4014 - Contemporary Theatre Seminar (3 credits)
Issues and concerns in contemporary theatre; production philosophies and approaches, employment opportunities, career options, and preparation of portfolio and resume materials. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4304 - Theatre Outreach (1-3 credits)
Participation in theatre projects or activities that focus on community and social issues. May be repeated for a maximum of six credits. Junior standing.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

TA 4315 - Directing (3 credits)
Script analysis, theories, techniques, and practical applications of theatrical direction. 4315: Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. 4316: Rehearsal techniques, style determination realism, and non-realism. Senior standing required.
Prerequisite(s): TA 2134 and TA 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4316 - Directing (3 credits)
Script analysis, theories, techniques, and practical applications of theatrical direction. 4315: Theories and aesthetics of directing, functions of the director, script analysis, basic principles and techniques of staging. 4316: Rehearsal techniques, style determination realism, and non-realism.
Prerequisite(s): TA 4315
Instructional Contact Hours: (3 Lec, 3 Crd)

TA 4704 - Professional Theatre Internship (9-15 credits)
Internship of one semester in acting, directing, management, design, or technical theatre or cinema with a professional equity company for selected advanced students; classroom, workshop, and production experiences. Minimum 9 credits, maximum 15 credits. Audition and consent.
Instructional Contact Hours: (9-15 Lec, 9-15 Crd)
Repeatability: up to 15 credit hours

TA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

TA 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Cinema Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
TA 2114	Script Analysis	3
TA 2134	Acting Lab	3
TA 2164	Scene Design Lab	3
TA 2174	Costume Design Lab	3
Select five credits of the following:		5
TA 3014	Theatre Production Lab Repeatable course up to 9 credits	
3014 must be taken at least once in each of the topics below. The two additional credits may be earned under any topic.		
Scene Shop Lab - Req. [1]		
Costume Lab - Req.		
Production Run Crew Lab - Req.		
TA 3105	History of Drama and Theatre	3
TA 3106	History of Drama and Theatre	3
TA 4315	Directing	3
Subtotal		26
Major Requirements		
TA 2014	Introduction to Theatre	3
TA 2104	Fundamentals of Theatre and Production	3
CINE 2054	Introduction to Cinema	3
CINE 2064	Introduction to Cinema Production	3
CINE 3184	Cinema Production Topics (Nine credits required. 3184 is repeatable for credit under different topics for up to nine hours.)	9
CINE 3214	Fiction Cinema Production	3
CINE 3224	Documentary Cinema Production	3
Take three of the following (nine credit hours required)		9
CINE 3514	American Cinema Genres	
CINE 3524	The Cinema Director	
CINE 3534	Avant-Garde Cinema	
CINE 4084	Cinema History	
CINE 4144	Topics in Cinema Studies Repeatable for credit under different topics for up to 9 credit hours	
CINE 4534	Underground Cinema and Culture	
Subtotal		36
Free Electives		
Select 13 credits of free electives		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		

Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

[1] Usually enrolled concurrent with TA 2414 Stage and Lighting Technology.

Note:

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Theatre Arts Major with Design Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
TA 2114	Script Analysis	3
TA 2134	Acting Lab	3
TA 2164	Scene Design Lab	3
TA 2174	Costume Design Lab	3
Select five credits of the following:		5
TA 3014	Theatre Production Lab Repeatable course up to 9 credits	
3014 must be taken at least once in each of the topics below. The two additional credits may be earned under any topic.		
Scene Shop Lab - Req.		
Costume Lab - Req.		
Production Run Crew Lab - Req.		
TA 3105	History of Drama and Theatre	3
TA 3106	History of Drama and Theatre	3
TA 4315	Directing	3
Subtotal		26
Major Requirements		
TA 2014	Introduction to Theatre	3
CINE 2054	Introduction to Cinema	3
Subtotal		6
Design Option Required Courses		
TA 2104	Fundamentals of Theatre and Production	3
TA 2414	Stage and Lighting Technology	3
Select nine credit hours of the following:		9
TA 3104	Sound Technology Topics (variable credit)	
TA 3114	Scenography Topics (variable credit)	
TA 3124	Costume Design and Technology Topics (variable credit)	
TA 3134	Lighting Topics (variable credit)	
TA 3144	Theatre Technology Topics (variable credit)	
Select nine credit hours of Restricted Electives from the list of approved courses		9
Subtotal		24
Free Electives		
Select 19 credits of free electives		19
Subtotal		19
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

Note:

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

No Theatre and Cinema classes, except for Topics courses may be counted for more than one place on the checksheet, unless otherwise indicated.)

Restricted Electives

Code	Title	Credits
DANC 2004	Anatomy for Performers [1]	3
TA/AFST/ENGL 2044	Contemporary African American Theatre [1]	3
CINE 2064	Introduction to Cinema Production	3
TA 2144	Foundations of Movement and Voice	3
TA 2204	Creative Dance [1]	3
TA 2224	Intermediate Performance Intensive	3

TA 2404	Introduction to Applied Collaborative Techniques [1]	3
DANC 2024	Introduction to Dance Techniques (may be repeated 3 times with different content) [1]	3
TA/MUS 2604	Introduction to Arts Marketing	3
TA 2964	Field Study (variable credit)	1-19
TA 2974	Independent Study (variable credit)	1-19
DANC 3024	Intermediate/Advanced Dance Techniques (may be repeated 3 times with different content) [1]	3
TA 3104	Sound Technology Topics (variable credit; 9 credits max)	3-6
TA 3114	Scenography Topics (variable credit; 9 credits max)	9
TA 3124	Costume Design and Technology Topics (variable credit; 9 credits max)	1-9
TA 3134	Lighting Topics (variable credit; 9 credits max)	1-9
TA 3144	Theatre Technology Topics (variable credit; 9 credits max)	9
TA 3154	Acting Topics (variable credit; 9 credits max)	9
TA 3164	Voice and Speech Topics (variable credit; 9 credits max)	9
TA 3174	Movement Topics (variable credit; 9 credits max)	9
CINE 3184	Cinema Production Topics (variable credit; 9 credits max)	1-9
CINE 3214	Fiction Cinema Production	3
CINE 3224	Documentary Cinema Production	3
TA/ENGL 3315	Playwriting	3
CINE/AFST 3444	African American Images in Film	3
CINE 3514	American Cinema Genres	3
CINE 3524	The Cinema Director	3
CINE 3534	Avant-Garde Cinema	3
CINE/ENGL 3544	Literature and Cinema	3
TA 3604	Arts Management	3
TA 3624	Stage Management	3
TA 3954	Study Abroad (variable credit)	1-19
TA 4014	Contemporary Theatre Seminar	3
CINE 4084	Cinema History	3
CINE 4144	Topics in Cinema Studies (9 credits max.) [1]	3
TA 4304	Theatre Outreach	1-3
TA 4316	Directing	3
CINE 4534	Underground Cinema and Culture	3
TA 4704	Professional Theatre Internship (variable credit/9 min., 15 max)	9-15
TA 4964	Field Study (variable credit)	1-19
TA 4974	Independent Study (variable credit)	1-19
TA 4994	Undergraduate Research (variable credit)	1-19

[1] Pathways Course

Theatre Arts Major with General Theatre Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
TA 2114	Script Analysis	3
TA 2134	Acting Lab	3
TA 2164	Scene Design Lab	3
TA 2174	Costume Design Lab	3
Lab Options		
Complete five credits of the following repeatable course(s):		5
TA 3014	Theatre Production Lab (Must be taken at least once under the below topics. The additional credits may be earned under any topic.)	
Scene Shop Lab - Req. [1]		
Costume Lab - Req.		
Production Run Crew Lab - Req.		
TA 3105	History of Drama and Theatre	3
TA 3106	History of Drama and Theatre	3
TA 4315	Directing	3
Subtotal		26
Major Requirements		
TA 2014	Introduction to Theatre	3
CINE 2054	Introduction to Cinema	3
Subtotal		6
Option Required Courses		
Select one of the following options:		6
Option A		
TA 2104	Fundamentals of Theatre and Production	
TA 2414	Stage and Lighting Technology	
Option B		
CINE 2064	Introduction to Cinema Production	
CINE 3214	Fiction Cinema Production	
or CINE 3224	Documentary Cinema Production	
Subtotal		6
Restricted Electives		
Select nine credit hours of Restricted Electives from the list of approved courses		9
Subtotal		9
Free Electives		
Select 28 credits of free electives		28
Subtotal		28
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6

Pathways Concept 3 - Reasoning in the Social Sciences	
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

[1] Usually enrolled concurrent with TA 2414 Stage and Lighting Technology.

Note:

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

No Theatre and Cinema classes, except for Topics courses may be counted for more than one place on the checksheet, unless otherwise indicated.

Theatre Arts and Cinema Electives

Code	Title	Credits
DANC 2004	Anatomy for Performers [1]	3
TA/AFST/ENGL 2044	Contemporary African American Theatre [1]	3
CINE 2064	Introduction to Cinema Production	3
TA 2144	Foundations of Movement and Voice	3
TA 2204	Creative Dance [1]	3
TA 2224	Intermediate Performance Intensive	3
TA 2404	Introduction to Applied Collaborative Techniques [1]	3
DANC 2024	Introduction to Dance Techniques (may be repeated 3 times with different content) [1]	3
TA/MUS 2604	Introduction to Arts Marketing	3
TA 2964	Field Study (variable credit)	1-19
TA 2974	Independent Study (variable credit)	1-19
DANC 3024	Intermediate/Advanced Dance Techniques (may be repeated 3 times with different content) [1]	3
TA 3104	Sound Technology Topics (variable credit; 9 credits max)	3-6
TA 3114	Scenography Topics (variable credit; 9 credits max)	9
TA 3124	Costume Design and Technology Topics (variable credit; 9 credits max)	1-9
TA 3134	Lighting Topics (variable credit; 9 credits max)	1-9
TA 3144	Theatre Technology Topics (variable credit; 9 credits max)	9
TA 3154	Acting Topics (variable credit; 9 credits max)	9
TA 3164	Voice and Speech Topics (variable credit; 9 credits max)	9
TA 3174	Movement Topics (variable credit; 9 credits max)	9
CINE 3184	Cinema Production Topics (variable credit; 9 credits max)	1-9
CINE 3214	Fiction Cinema Production	3
CINE 3224	Documentary Cinema Production	3
TA/ENGL 3315	Playwriting	3
CINE/AFST 3444	African American Images in Film	3
CINE 3514	American Cinema Genres	3
CINE 3524	The Cinema Director	3
CINE 3534	Avant-Garde Cinema	3
CINE/ENGL 3544	Literature and Cinema	3
TA 3604	Arts Management	3
TA 3624	Stage Management	3
TA 3954	Study Abroad (variable credit)	1-19
TA 4014	Contemporary Theatre Seminar	3
CINE 4084	Cinema History	3
CINE 4144	Topics in Cinema Studies (9 credits max.) [1]	3
TA 4304	Theatre Outreach	1-3
TA 4316	Directing	3
CINE 4534	Underground Cinema and Culture	3
TA 4704	Professional Theatre Internship (variable credit/9 min., 15 max)	9-15
TA 4964	Field Study (variable credit)	1-19
TA 4974	Independent Study (variable credit)	1-19
TA 4994	Undergraduate Research (variable credit)	1-19

[1] Pathways Course

Theatre Arts Major with Performance Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
TA 2114	Script Analysis	3
TA 2134	Acting Lab	3
TA 2164	Scene Design Lab	3
TA 2174	Costume Design Lab	3
Select five credits of the following:		5

TA 3014	Theatre Production Lab [Repeatable course up to 9 credits]	
3014 must be taken at least once in the three required topics listed below. The two additional credits can be taken under any topic.		
Scene Shop Lab - Req. [1]		
Costume Lab - Req.		
Production Run Crew Lab - Req.		
TA 3105	History of Drama and Theatre	3
TA 3106	History of Drama and Theatre	3
TA 4315	Directing	3
Subtotal		26
Major Requirements		
TA 2014	Introduction to Theatre	3
CINE 2054	Introduction to Cinema	3
Subtotal		6
Theatre Performance Option Required Courses		
TA 2104	Fundamentals of Theatre and Production	3
TA 2414	Stage and Lighting Technology	3
Select nine credit hours of the following:		9
TA 2144	Foundations of Movement and Voice	
TA 2224	Intermediate Performance Intensive	
TA 3154	Acting Topics (variable credit; 9 credits max.)	
TA 3164	Voice and Speech Topics (variable credit; 9 credits max.)	
TA 3174	Movement Topics (variable credit; 9 credits max.)	
Subtotal		15
Restricted Electives		
Select nine credit hours of Restricted Electives from the list of approved courses		9
Subtotal		9
Free Electives		
Select 19 credits of free electives		19
Subtotal		19
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] Usually enrolled concurrent with TA 2414 Stage and Lighting Technology.

Note:

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

No Theatre and Cinema classes, except for Topics courses, may be counted for more than one place on the checksheet, unless otherwise indicated.

Restricted Electives

Code	Title	Credits
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TA 2144	Foundations of Movement and Voice	3
TA 2204	Creative Dance [1]	3
TA 2224	Intermediate Performance Intensive	3
TA 2404	Introduction to Applied Collaborative Techniques [1]	3
DANC 2024	Introduction to Dance Techniques (may be repeated 3 times with different content) [1]	3
TA/MUS 2604	Introduction to Arts Marketing	3
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TA 2974	Independent Study (variable credit)	1-19
DANC 3024	Intermediate/Advanced Dance Techniques (may be repeated 3 times with different content) [1]	3
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TA 3134	Lighting Topics (variable credit; 9 credits max)	1-9
TA 3144	Theatre Technology Topics (variable credit; 9 credits max)	9
TA 3154	Acting Topics (variable credit; 9 credits max)	9

TA 3164	Voice and Speech Topics (variable credit; 9 credits max)	9
TA 3174	Movement Topics (variable credit; 9 credits max)	9
CINE 3184	Cinema Production Topics (variable credit; 9 credits max)	1-9
CINE 3214	Fiction Cinema Production	3
CINE 3224	Documentary Cinema Production	3
TA/ENGL 3315	Playwriting	3
CINE/AFST 3444	African American Images in Film	3
CINE 3514	American Cinema Genres	3
CINE 3524	The Cinema Director	3
CINE 3534	Avant-Garde Cinema	3
CINE/ENGL 3544	Literature and Cinema	3
TA 3604	Arts Management	3
TA 3624	Stage Management	3
TA 3954	Study Abroad (variable credit)	1-19
TA 4014	Contemporary Theatre Seminar	3
CINE 4084	Cinema History	3
CINE 4144	Topics in Cinema Studies (9 credits max.) [1]	3
TA 4304	Theatre Outreach	1-3
TA 4316	Directing	3
CINE 4534	Underground Cinema and Culture	3
TA 4704	Professional Theatre Internship (variable credit/9 min., 15 max)	9-15
TA 4964	Field Study (variable credit)	1-19
TA 4974	Independent Study (variable credit)	1-19
TA 4994	Undergraduate Research (variable credit)	1-19

Pamplin College of Business

Our Website (http://www.pamplin.vt.edu)

Overview

Range of Programs

The Pamplin College of Business offers a Bachelor of Science in Business degree, a Bachelor of Science in Business in Business Information Technology degree, a Bachelor of Science in Business in Finance degree, and a Bachelor of Science in Business in Management degree. Majors in Accounting and Information Systems; Business Information Technology; Cybersecurity Management and Analytics; Entrepreneurship, Innovation & Technology Management; Finance; Financial Planning and Wealth Management; FinTech and Big Data Analytics; Hospitality and Tourism Management; Human Resources Management; Management; Management Consulting and Analytics, Marketing; and Real Estate Finance are available. The College also offers a Bachelor of Science in Real Estate degree with majors in Real Estate for Commercial Properties and Real Estate for Residential Properties. On-campus enrollment is over 5,000 undergraduate and about 200 full-time graduate students in the MS-BA in Business Analytics, Master of Accounting and Information Systems, and Ph.D. programs resident in Blacksburg, VA. The college also enrolls approximately 140 Evening MBA, and about 50 MS-BA students in Hospitality and Tourism at Virginia Tech's campuses in greater Washington, D.C., metro area. In addition to offering the in-person Evening MBA program, the college offers a fully virtual Online MBA program. The OMBA program was launched in the summer of 2021 and enrolls a cohort of approximately 30 students once per year. Virginia Tech's Master of Information Technology (VT-MIT) is a 33-credit interdisciplinary degree program offered jointly by the College of Engineering and Pamplin College of Business. Designed for working professionals, the program is fully online, asynchronous, and offers a highly customizable curriculum in areas such as big data, data analytics, cybersecurity, health IT, and software development. The VT-MIT program also offers 10 graduate certificates that can be earned with the degree or as a stand-alone credential. In addition, the College also has about 50 students in the Executive Ph.D. in Business with residencies at the Falls Church and Blacksburg campuses.

Competitive Advantages of Pamplin

The college offers five distinct competitive advantages:

1. start in the business school from day one
2. graduate with a strong business foundation
3. get jobs (over 90% with a job in their field at graduation)
4. develop skills through hands-on experiences
5. connect with engaged alumni

Groundbreaking Research, Eminent Scholarship

Pamplin faculty members are tackling major issues in industry, finance, management practice, and information technology, to name a few areas. Their research has contributed to greater understanding of business issues, been cited in government hearings and court testimony, and played a role in policy making. Though sponsored research is not a central aspect of the research programs of business schools, several Pamplin faculty members have attracted national funding for their research, working as members of interdisciplinary teams. The college's departments are also regularly ranked among the nation's or world's top programs for scholarly productivity, based on article publication in the leading academic journals in their fields.

Centers

The college offers two centers devoted to helping students and corporations gain more knowledge. The Apex Systems Center for Innovation and Entrepreneurship helps students to learn, lead, and launch. Students will learn to be empowered with skills, tools, and information to create successful ventures. They will launch ventures through support and resources that will help them transform vision to reality. Finally, the center will lead the next generation of entrepreneurs and help them to have courage to build exceptional ventures. The Center for Business Intelligence and Analytics will assist with big data and harnessing analytic techniques to transform raw data into useful information for better business decisions.

Curriculum

The curriculum for the business degrees includes a broad liberal education and business core foundation of two years, followed by a college core in the fundamentals of business theory and concentration in one of the following majors:

- Accounting and Information Systems
- Business Information Technology
- Cybersecurity Management and Analytics
- Entrepreneurship, Innovation, and Technology Management
- Finance
- Financial Planning and Wealth Management
- FinTech and Big Data Analytics
- Hospitality and Tourism Management
- Human Resource Management

- Management
- Management Consulting and Analytics
- Marketing
- Real Estate Finance

The Blackwood Program in Real Estate offers a Bachelor of Science in Real Estate degree, with majors in Real Estate for Commercial Properties and Real Estate for Residential Properties. Real estate is integral to where one works, shops, lives and recreates. Thus, Real Estate courses integrate the material students learn in disciplinary courses such as finance, law, and property management through experiential learning within the academic program. The integration occurs though a university-industry partnership where real estate professionals are actively involved in students' education through guest lectures, mentoring experiences, and by providing internship opportunities.

Academic Advising

Academic advising is an important aspect of each student's college career. Students are assigned to a professional academic advisor to assist from entry in Pamplin until graduation. All business degree students are assigned to an advisor in Pamplin Undergraduate Programs, 1046 Pamplin Hall. Real Estate degree students are assigned to an advisor in the Blackwood Real Estate program, also located within Pamplin Hall.

Undergraduates are strongly encouraged to participate in extra-curricular activities, particularly the annual career fairs in September and January, ethics and leadership seminars, college international programs and study abroad, and the various events of the over 30 different student clubs in the college. Many of these programs provide critical insights into the careers for which students are preparing, as well as valuable opportunities for leadership.

Undergraduates are required to bring a computer to the university, as well as purchase university and Pamplin software bundles. The computer is used extensively in the curriculum. Purchase information and required configuration will be available each spring.

Facilities

Administrative and faculty offices for the college are located in Pamplin, Wallace, and Bishop-Favrao Halls. Our facilities also include study rooms, computer labs, conference rooms, a behavioral laboratory, kitchen laboratory, atrium filled with furniture conducive to studying and group work, and a student organization office center.

Accreditation

The college is a member of The Association to Advance Collegiate Schools of Business, AACSB International. All programs are accredited by the AACSB. Additionally, the ACIS program holds an accreditation from AACSB: AACSB Accounting Accreditation. The Finance department is accredited through the Certified Financial Planning Board of Standards, Inc.

General Requirements for Graduation

A minimum of 125 credit hours is required for graduation in the Bachelor of Science in Business, Bachelor of Science in Business in Business Information Technology, Bachelor of Science in Business in Finance, and Bachelor of Science in Business in Management degrees. The Bachelor of Science in Real Estate requires 120 credit hours.

Students must have an overall average and in-major GPA of 2.0 ("C") to graduate.

To ensure credit, a student desiring to take courses at another institution must secure approval from Pamplin Undergraduate Programs before registering for the course at another institution. Completion of the "Authorization to Take Courses Elsewhere" must be submitted online. The student will be notified of the outcome via email.

General university limitations on acceptability of transfer credit are shown elsewhere in this catalog.

Program for First Two Years

All business degree-seeking students generally take the same required courses for the first two years. Courses consist of business foundation courses as well as general education requirements and free electives. Pamplin enforces a strict policy of progress toward degree (Policy 91). Policy 91 states that students must complete the following courses with grades no lower than C- by the time they have attempted 72 credit hours (90 hours for transfer students): ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics. Students who do not meet this progress towards degree requirement will be dismissed from their major.

Business Core

All business degree-seeking students complete a business core that creates a strong foundation in all aspects of business and includes coursework in accounting, economics, finance, marketing, management, information technology, and international business. All core courses require a grade of C- or better or else the course must be repeated. However, students at the university may only attempt a course three times.

Restricted Majors

ACIS, BIT, CFPF, CMA, EIT, FIN, FBDA, HTM, MCA, MGT,MHR, MKTG, and FREL are considered restricted majors and require application from students who did not start at VT enrolled in one of those majors. Students must complete certain business courses and obtain a minimum GPA for eligibility to apply to a restricted major. Applications are accepted online three times per year – January, May, and August.

Pamplin College of Business Minors

Business Minor

Real Estate students not double majoring in a business degree and students pursuing a major outside the Pamplin College may apply for a minor in business if they have a minimum 2.0 overall GPA and have completed the math requirement. The minor consists of approximately 46 credit hours of foundational coursework in various areas of business. To complete the minor in business, students must have a 2.0 GPA in all required courses.

The requirements to earn a minor in business can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Digital Marketing Strategy Minor

Digital marketing encompasses many areas of application, including mobile marketing, Internet marketing, e-commerce, and social media marketing. The Digital Marketing Strategy minor enables students to acquire knowledge and skills in online and digital business and digital product delivery, as well as development, analysis, and enhancement of a company's presences on the web, mobile, and social networks. The minor is open to all majors and requires 21 credit hours of coursework.

The requirements to earn a minor in digital marketing strategy can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Entrepreneurship-New Venture Growth Minor

The Entrepreneurship-New Venture Growth Minor is intended to focus on the knowledge and skills needed to create new ventures and lead their early growth. The objective is to provide students with the knowledge to convert ideas into business successes, particularly in the context of engineering and science-based technology commercialization.

The minor is open to students pursuing a major outside the Pamplin College of Business and Real Estate students not double majoring in a business degree and requires 18 credit hours of coursework.

The requirements to earn a minor in entrepreneurship can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Environmental, Social, and Governance Analytics Minor

Environmental, social, and governance policies and practices are increasingly a focus in the conduct of business and finance. The Department of Finance has developed an ESG minor to make students, especially Business majors, aware of environmental, social, and governance criteria that are used in evaluation of companies and investments. The minor will prepare students to understand the effect of ESG on investment performance, access to funding, and evaluation of corporate policies. The minor requires 24 credit hours, a grade of C or better in each relevant course, and that students maintain a GPA of at least 2.0 in the required course work.

Event and Experience Management Minor

The Hospitality & Tourism department's Pathway's minor in Event and Experience Management is available to all students across campus and provides options of emphasis in sales management or event operations management. The minor consists of 18 hours of study and provides students with content and practical experiences leading to professional growth opportunities in the event management industry. In the United States alone, there are over 18 million events and meetings organized every year creating career opportunities for students who aspire to design, plan and manage the execution of events or for those who prefer the challenge of sales and the techniques involved in building customer relationships through effective communication and interpersonal skills.

The requirements to earn a minor in event and experience management can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Finance Minor

Students pursuing a major outside the Pamplin College of Business and Real Estate students not double majoring in a business degree, may apply for a minor in Finance if they have a minimum 2.50 overall GPA, have completed 24 hours at Virginia Tech, and have completed the math requirement. The minor consists of 27 credit hours of coursework in Finance and supporting areas of business. To complete the minor in business, students must have a 2.0 GPA in all required courses.

The requirements to earn a minor in finance can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Global Business Practices to Improve the Human Condition

Any student at Virginia Tech can put Ut Prosim into action by completing the Minor in Global Business Practices (GBP) to Improve the Human Condition. This interdisciplinary minor will teach students how to address societal issues using sound business practices in an international setting. The GBP minor was designed for any Virginia Tech student with a GPA of at least 2.0. Students will complete coursework in Pathways 3, 5f, and 7. The 21-credit minor includes 12 credits of required core courses, 6 credits of elective courses concentrating in either the social change or prosperity track, and a 3 credit capstone experience.

The requirements to earn a minor in global business practices can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

International Business Minor

The International Business (IB) Minor was designed for all Virginia Tech students who wish to learn how to conduct business in an international setting. Students will be exposed to a wide variety of business, cultural, and global perspectives. The international business minor provides students with a rigorous foundation for success in today's global business environment. Freshman, sophomores, juniors, and seniors who have at least a 2.0 overall GPA are eligible for the International Business minor. The minor consists of 18 credit hours of course work, four years of a foreign language (may be satisfied from high school), and an approved international experience. Non-Pamplin students who wish to earn the minor must go on a Pamplin-specific study abroad or international internship.

The requirements to earn a minor in international business can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Leadership Centers and Minors

The **Business Leadership Center (BLC)** within the Department of Management provides multi-disciplinary, experiential education in the history, values, skills, and theory of organizational and team leadership. It acts as an educational center that coordinates programs to help students develop leadership skills that are necessary to excel and prosper in the workplace of the twenty-first century.

The 18-credit minor in Organizational Leadership is open to students in all majors who have at least a 2.5 overall GPA at Virginia Tech. It includes required courses in team and organizational leadership; elective courses that address a broad range of competencies in four areas, including Creativity and Innovation, Critical and Strategic Thinking, Intercultural Communications, and Holistic Thinking and Ethical Reasoning. and a required leadership experiential activity. For additional information, contact Mr. Ron Poff, Interim Business Leadership Center Director, (540) 231-1279, leadershipcenter@vt.edu.

The requirements to earn a minor in organizational leadership can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Housed within the Virginia Tech Corps of Cadets (VTCC), the mission of the Major General W. Thomas Rice Center for Leader Development is to foster the next generation of public leaders by integrating theory and practice through scholarly dialogue and experiential learning in the areas of leadership, civic responsibility, service, and moral values thus contributing to the development of informed and responsible individuals who are committed to making a difference in their nation and in the world. The Rice Center oversees the 22-credit leadership Minor Corps of Cadets (LMCC). This minor is only available to graduates of the VTCC. For more information on the minor in leadership, please contact the Rice Center for Leader Development at (540) 231-9455.

Professional Sales Minor

Sales positions are critical to all firms and sales positions are expected to increase by as much as 25% over the next several years. This has created strong competition among employers to recruit the very best graduates. The Professional Sales minor is designed to prepare students to excel in this highly lucrative field. The focus of the program is to provide students with critical communication, interpersonal, and presentation skills key to helping organizations build long-term customer relationships. These skills will be valuable not only to those pursuing sales careers but also to anyone aspiring to managerial positions - positions that involve presentation of plans and ideas, negotiations, and persuasion. This minor requires 21 credits to be completed with at least a 2.0 GPA overall and within the courses. The minor is open to all Virginia Tech students

The requirements to earn a minor in professional sales can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Real Estate Minor

The Real Estate minor allows students with a general interest in real estate to select a set of courses that will advance their knowledge the industry. The minor requires 28 credit hours in coursework across various disciplines including property management, finance, marketing, building construction, and real estate. The minor is open to all Virginia Tech students.

The requirements to earn a minor in real estate can be found on the University Registrar website https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Cooperative Education Programs in Business

The college participates in the Cooperative Education Program in which qualified students may alternate semesters of study in the major with semesters of professional employment. Additional information pertaining to the program is included in the "Academics (p. 9)" section of this catalog.

Graduate Programs in Business

Graduate instruction and opportunities for research are offered to students who have bachelor's degrees from accredited colleges. The college offers Master of Business Administration programs, and master's and Ph.D. degrees in all departments. All graduate students are required to attain a satisfactory score on the Graduate Management Admission Test (GMAT).

Preparation for Law

The four-year course work leading to the B.S. in Business degree in any major in the college provides a sound preparation for law school, and pre-law advisors from the Pamplin faculty are provided.

- Accounting & Business Analysis Major (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/accounting--business-analysis/)
- Accounting & Information Systems Major with Accounting & Auditing Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-accounting-auditing/)
- Accounting & Information Systems Major with Tax Compliance & Planning Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-tax-compliance--planning/)
- Accounting and Information Systems Major with Accounting Information Systems & Controls Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-accounting-information-systems-controls/)
- Business Information Technology Major with Computer-Based Decision Support Systems Option (p. 670)
- Business Information Technology Major with Operations and Supply Chain Management Option (p. 673)
- Cybersecurity Management and Analytics Major (p. 676)
- Entrepreneurship, Innovation & Technology Management Major (p. 733)
- Event & Experience Management Major (https://catalog.vt.edu/undergraduate/pamplin-college-business/hospitality-tourism-management/event-experience-management/)
- Finance and Real Estate Major (p. 684)
- Finance Major with Corporate Financial Management Option (p. 687)
- Finance Major with Financial Accounting Option (p. 691)
- Finance Major with Financial Risk Management Option (p. 694)
- Finance Major with Investment Management and Chartered Financial Analyst Option (p. 697)
- Financial Planning and Wealth Management Major (p. 700)
- FinTech and Big Data Analytics Major (p. 703)
- Hospitality and Tourism Management Major (p. 710)
- Hospitality and Tourism Management Major with Analytics Option (p. 714)
- Hospitality and Tourism Management Major with Entrepreneurship and Innovation Option (p. 717)
- Hospitality and Tourism Management Major with Services Management Option (p. 720)
- Hospitality and Tourism Management Major with Sustainability, Ethics, & Advocacy Option (p. 723)
- Human Resource Management Major (p. 736)
- Management Consulting and Analytics Major (p. 739)
- Management Major (p. 741)
- Marketing Management Major (p. 748)

- Marketing Management Major with Digital Marketing Strategy Option (p. 751)
- Marketing Management Major with Professional Sales Option (p. 755)
- Real Estate for Commercial Properties Major (p. 760)
- Real Estate for Residential Properties Major (p. 763)

Dean: Saonee Sarker
Assistant Dean for Finance and Administration: Beth Osborne
Associate Dean for Graduate Programs: Parviz Ghandforoush
Interim Associate Dean for Research and Faculty Affairs: Lara Khansa
Associate Dean for Undergraduate Programs: Lara Khansa
Assistant Dean for Outreach and Engagement: Michelle Seref

Accounting and Information Systems

Our Website (http://www.acis.pamplin.vt.edu)

Our Mission

The Department of Accounting and Information Systems in the Pamplin College of Business strives for excellence in fulfilling the three missions of a comprehensive land grant university by:

- Improving the accounting and information systems professions by conducting quality research and disseminating the results;
- Providing a world class accounting and information systems education to our students; and
- Delivering outreach services to accounting and information systems professionals and educators.

The department seeks to fulfill the teaching mission through programs which include:

Undergraduate Programs, where we seek to

- *Prepare students to enter the accounting and information systems professions with the skills and knowledge of business, information systems, and accounting concepts and practices.*

Masters of Accounting and Information Systems, where we seek to

- *Prepare students for professional careers with specializations in accounting analytics, audit, financial services, information systems, and taxation.*

Ph.D. Program in Business with a major in Accounting and Information Systems, where we seek to

- *Prepare students for academic careers in research and teaching.*

The Department of Accounting and Information Systems prepares students to become professionals in their chosen area of accounting and information systems. Faculty members in the department have chosen to specialize in selected areas of accounting or information systems and they teach and conduct research in these areas. All tenure track faculty members at the professorial ranks have Ph.D.s in accounting or information systems appropriate to the courses they teach, and many have professional certification in their areas of specialization. The faculty is committed to the education of accounting and information systems professionals who will be active participants in the information age, with increasing demand for data analytics skills.

The department's undergraduate program offers two majors. Both majors provide a fundamental education for careers in public accounting (CPA) firms, large and small corporations, government agencies, or nonprofit organizations.

- The **Accounting and Information Systems Major** is designed to help prepare graduates for the broadest range of accounting careers, including those in public accounting that require the CPA professional certification. This major has three options:
  - Accounting & Auditing
  - Tax Compliance & Planning
  - Accounting Information Systems & Controls
- The **Accounting & Business Analysis Major** is designed to provide students with flexibility to combine a core accounting education with a leading-edge specialty in accounting, business analytics, or another discipline.

The job titles vary greatly and include auditor, information systems auditor, forensic accountant, management accountant, tax professional, systems consultant, controller, financial data analytics specialist, and cost analyst. The demand for our graduates has been very strong throughout the department's history, and this strong demand continues.

Many graduates of our department desire to gain licensure and/or certification in their selected area of specialization. The Certified Public Accountant (CPA) license is highly respected and sought after in addition to being globally recognized. Students planning to take the CPA exam in Virginia are required to have a bachelor's degree from one or more accredited institutions with an accounting concentration or equivalent (as defined by the Virginia Board of Accountancy) and at least 120 semester credit hours (SCH). 150 SCH are ultimately required for CPA licensure. The best preparations is to earn a Master's degree in Accounting and Information Systems; however, Virginia Tech offers other options for meeting these requirements. If interested, students should discuss with their advisor and/or department's faculty. Students should be aware that education requirements vary by state (consult the state board of accountancy of interest). In addition to the CPA license, graduates of our programs sit for the Certificate in Management Accounting (CMA) exam, the Certified Internal Auditor (CIA) exam, the Certified Information Systems Auditor (CISA) exam, the Certified Fraud Examiner (CFE) exam, the Certified Financial Planner (CFP) exam, and others. Students planning to take one or more of these exams are advised to talk to the department's faculty during their junior year so that they may select the electives appropriate for the respective certification(s).

The department encourages its students to gain "real world" **experience** prior to graduation through an internship or by participating in the Cooperative Education Program. More information about these programs is available either from the department's faculty or Career Services.

The department also encourages **interaction with accounting and information systems professionals** by sponsoring three student organizations: Accounting Society; National Association of Black Accountants; and Beta Alpha Psi, the national honorary and professional society dedicated to the advancement of the accounting profession. These organizations and other campus groups provide multiple opportunities for developing leadership skills and interacting with accounting and information systems professionals.

The department encourages students to gain a **global perspective** of business through modules on international issues in our courses, by participation in the college's International Business Minor and/or by participating in one or more of the college's study abroad programs. Our

goal is to encourage our students to become well-rounded professionals who will become leaders in their chosen careers.

Lastly, many of the department's 7,000 plus alumni have generously contributed to a variety of scholarships for accounting and information systems majors. Each year the department awards over $500,000 in scholarships to our students.

Course Requirements

Students graduating from the Department of Accounting and Information Systems must have a minimum quality credit average (GPA) of 2.00 in upper-division (3000 and 4000 level) accounting and information systems courses (the in-major GPA) as well as an overall GPA of 2.00 for all courses taken at Virginia Tech.

During their sophomore year, students in the Accounting & Information Systems major must select one of the three options: Accounting & Auditing (AAA), Tax Compliance & Planning (TCP), or Accounting Information Systems & Controls (ASYS). These options are more fully described below. There are no options under the Accounting & Business Analysis (ABA) major.

Degree Requirements

The graduation requirements in effect during the academic year of admission to Virginia Tech apply. Requirements for graduation are listed under the Programs tab in the undergraduate catalog for the appropriate year of entry.

Accounting & Information Sytems Major - Accounting & Auditing Option (AAA)

The Accounting & Auditing Option prepares students for careers in the preparation, reporting, audit, analysis, and use of financial information. Graduates from the Accounting & Auditing Option go on to careers as accountants, auditors, chief financial officers, consultants, controllers, cost accountants, financial analysts, forensic accountants, partners, business owners, treasurers, etc.

Accounting & Information Systems Major - Tax Compliance & Planning Option (TCP)

The Tax Compliance & Planning Option prepares students for careers in individual and business tax planning, compliance, and consulting. Graduates from the Tax Compliance & Planning Option go on to careers as tax preparers, tax consultants, financial planners, partners, etc.

Accounting & Information Systems Major - Accounting Information Systems & Controls Option (ASYS)

The Accounting Information Systems & Controls Option is an innovative systems program designed to prepare students for careers in assurance and advisory services pertaining to corporate technologies as well as related business processes. Graduates from the Accounting Information Systems & Controls Option go on to careers as information systems auditors, information systems professionals in enterprise risk assurance services, forensic accountants, consultants, partners, etc.

Accounting & Business Analysis Major (ABA)

The Accounting & Business Analysis Major allows students to select electives in the field of accounting as well as related disciplines to build a specialized background in Accounting Analytics, Artificial Intelligence & Accounting, Sustainability Accounting, or other emerging areas in accounting. This major also supports traditional corporate accounting careers such as cost accountant, internal auditor, management consultant, budget analyst, etc.

- Accounting & Business Analysis Major (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/accounting--business-analysis/)
- Accounting & Information Systems Major with Accounting & Auditing Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-accounting-auditing/)
- Accounting & Information Systems Major with Tax Compliance & Planning Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-tax-compliance--planning/)
- Accounting and Information Systems Major with Accounting Information Systems & Controls Option (https://catalog.vt.edu/undergraduate/pamplin-college-business/accounting-information-systems/bs-accounting-option-accounting-information-systems-controls/)

Head: Robert H. Davidson
Curling Visiting Professor: J.A. Pittman
John E. Peterson Professor: J.R. Joe
KPMG Professor: R. Barkhi
R. B. Pamplin Professor of Accounting and Information Systems: F. Belanger and R.H. Davidson
Thomas M. Wells and Kathy Dargo Professors: S. Bhattacharjee and J. J. Maher
University Distinguished Professor: F. Belanger
Wayne E. Leininger Professor: L.L. Lisic
Professors: S.D. Sheetz and L.G. Wallace
Associate Professors: A.A. Acito, J. Huang, S.E. Stein, L. Tan, D.P. Tegarden, and M.D. Vance
Assistant Professors: M.J. Erickson, M.K. Harding, S.M. Hillison, M.R. Lowry, and K. Walker
Collegiate Assistant Professors: D.P. Garner
Visiting Assistant Professor: M.A. Cobabe
Professors of Practice: D.R. Compton and N.A. Rogers
Associate Professors of Practice: J.M. Lacoste
Assistant Professors of Practice: R.A. Brassine, S.L. Ferris, G.J. Kogan, E.A. Martin, J.P. Sharp, and J.L. Shortt
Career Advisor: R. H. Davidson (231-6591)

Undergraduate Course Descriptions (ACIS)

ACIS 1004 - Accounting Foundations (3 credits)
Fundamentals of accounting, the language of business, including what accounting information is, how it is developed, how it is used and what it means. Financial Accounting including the application of accounting principles for real world, complex business transactions to classify these transactions, reflect their economic value, produce basic financial statements, evaluate financial position and make fundamental interpretations. Managerial Accounting including cost behaviors, budgeting and other management reporting to assist in internal decision making and performance analysis. Attention to accountants codes of ethics applied throughout. Emphasis placed on non-Business majors becoming informed users of accounting information. No credit will be given for ACIS 1004 if taken with or after ACIS 2115 or ACIS 2116.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 1104 - Careers in Accounting and Information Systems (1 credit)
Overview of career options in the accounting field. Real life perspective from industry expert guest speakers. Career skills and training requirements. Job search strategies. Job search strategies. Job market analysis. Effective professional materials creation. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

ACIS 1504 - Introduction to Business Analytics and Business Intelligence (3 credits)
Foundational data analytics using Microsoft Excel. Utilizes the data analytics framework and many Excel functions to address various business problems. Introduction to big datasets, how to navigate them, and the many complexities of using them, including relevant ethical issues. Identification and construction of various data visualizations and charts to be used in presentations.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ACIS 2024 - Small Business Accounting (3 credits)
Accounting to support starting and operating a small business. Includes setting up accounting records, creating budgets, pricing products and services, tracking revenues and expenses, planning for taxes, and accounting for borrowing, inventory, payroll, and long-term assets. Emphasis on performance evaluation using mathematical models including financial statements, budget variance models, and financial ratios. Accounting presented in compliance with Generally Accepted Accounting Principles (GAAP) and accountant's codes of ethics to support the prevention and detection of fraud.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 2115 - Principles of Accounting (3 credits)
Introduction to financial and managerial accounting. 2115: Emphasis on the financial accounting cycle. Discusses accounting information uses, fraud, and internal controls. Analysis of financial statement elements: assets, liabilities, stockholders' equity, revenues, and expenses. 2116: Emphasis on budgeting and accounting information decision-making. Discusses management accounting and cost concepts. Use of job order costing and cost value profit relationships. Use of variable costing and segment reporting. Create external financial reporting documents.
Corequisite(s): ACIS 1504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 2116 - Principles of Accounting (3 credits)
Introduction to financial and managerial accounting. 2115: Emphasis on the financial accounting cycle. Discusses accounting information uses, fraud, and internal controls. Analysis of financial statement elements: assets, liabilities, stockholders' equity, revenues, and expenses. 2116: Emphasis on budgeting and accounting information decision-making. Discusses management accounting and cost concepts. Use of job order costing and cost value profit relationships. Use of variable costing and segment reporting. Create external financial reporting documents.
Prerequisite(s): ACIS 2115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 2124 - Nonprofit Accounting and Financial Management (3 credits)
Accounting to support nonprofit companies. Includes, setting up nonprofit accounting records, identifying internal controls, and tax considerations. Nonprofit tracking revenues and expenses, grants, borrowing, payroll, and long-term assets. Emphasis on nonprofit performance evaluation using mathematical models including financial statements, budget variance models, and financial ratios. Use of ethical framework decision-making. Evaluation of government funding sources. No credit will be given for ACIS 2124 if taken with or after ACIS 4124.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 2504 - Introduction to Accounting Analytics (3 credits)
Design and creation of models used to perform accounting analytics. Cleansing, transformation, organization, analysis, and reporting of accounting data using analytics tools such as spreadsheets, programming, and accounting software applications. Display of accounting data using visualization techniques.
Prerequisite(s): ACIS 1504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. The course examines the accounting and information systems issues that impact the multinational business. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. Content will vary between semesters. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent. May be repeated for a maximum of 9 credit hours.
Instructional Contact Hours: Variable credit course
Repeatability: up to 9 credit hours

ACIS 3115 - Intermediate Financial Accounting (3 credits)
Intermediate financial accounting. 3115: In-depth analysis of basic concepts of external financial reporting. Includes asset and related transaction analysis and preparation of financial statements in accordance with generally accepted accounting principles. Discusses the historical development accounting theory and practice as well as discussion and exploration of international accounting standards and ongoing and potential developments in accounting practice. 3116: In-depth analysis of liability, equity, and tax related transactions and their subsequent impacts on financial reporting. Interpret financial accounting standards including requirements to adjust financial statements due to errors and corrections. Prepare the statement of cash flows in accordance with generally accepted accounting principles. Course credit will not be awarded for both ACIS 3115 and ACIS 4194.
Prerequisite(s): ACIS 2115
Corequisite(s): ACIS 2504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 3116 - Intermediate Financial Accounting (3 credits)
Intermediate financial accounting. 3115: In-depth analysis of basic concepts of external financial reporting. Includes asset and related transaction analysis and preparation of financial statements in accordance with generally accepted accounting principles. Discusses the historical development accounting theory and practice as well as discussion and exploration of international accounting standards and ongoing and potential developments in accounting practice. 3116: In-depth analysis of liability, equity, and tax related transactions and their subsequent impacts on financial reporting. Interpret financial accounting standards including requirements to adjust financial statements due to errors and corrections. Prepare the statement of cash flows in accordance with generally accepted accounting principles. Course credit will not be awarded for both ACIS 3115 and ACIS 4194.
Prerequisite(s): ACIS 3115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 3314 - Tax Impact on Decisions (3 credits)
Introduction to federal taxation for individuals and business entities with an emphasis on effective tax planning strategies. IRS tax compliance and discussion of other tax authorities. Individual tax overview includes filing status, gross income, exclusions, and deductions. Business tax overview includes business entity types, filing requirements, business income, deductions, accounting methods, property acquisitions, cost recovery, and property dispositions. Properly classify corporate operations to compute corporate taxable income.
Prerequisite(s): ACIS 3115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 3504 - Accounting Systems and Controls (3 credits)
Examines system design concepts and methods including an understanding of basic control structures. Covers specific accounting cycles and computerized transaction processing systems. Analyzes controls for manual and computerized systems including database systems.
Prerequisite(s): ACIS 2115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 3554 - Networks, Telecommunications and Security (3 credits)
Provides an introduction to computer networks and data communications in business. Topics include mechanisms for reliable data transfer, network topologies and technologies, and a comprehensive treatment of inter-networking. Additional topics include packet switching, and cloud, edge, and advanced networking. Security issues related to using computer networks are discussed, along with network design issues, and methodologies for network applications. Duplicates BIT 4554.
Prerequisite(s): BIT 2405 or ACIS 3504 or BIT 2164 or CS 2164 or PSCI 2164
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 3554

ACIS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ACIS 4024 - Information Systems Audit and Control (3 credits)
An introduction to the fundamentals of information systems auditing and controls. Emphasis on information systems controls and general application controls. Employment of computer assisted audit tools, techniques, and reporting languages. Implementation of different types of audit approaches including on line and continuous auditing as well as fraud and forensic auditing. Exposure to risk assessment, system-based guidelines, and professional standards in the field of information systems auditing. Examination of the implementation and deployment of information systems.
Prerequisite(s): ACIS 3504 and ACIS 4414
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4114 - Advanced Financial Accounting (3 credits)
Detailed analysis of external financial reporting. Study of debt and equity investments, derivatives, and foreign currency. Proper application of Securities and Exchange Commission reporting regulations.
Prerequisite(s): ACIS 3116
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4124 - Governmental and Nonprofit Accounting (3 credits)
Detailed analysis of U.S. state and local governmental, nonprofit, and federal accounting. Focus on entity characteristics, regulatory environment, fund accounting, financial transactions, and financial statements.
Prerequisite(s): ACIS 3115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4194 - Analysis of Financial Statements (3 credits)
Analysis of financial statements including how to interpret and assess a company's results of operations, financial condition, and cash flows. Construction and use of financial ratios for use in various contexts. Development of reports comparing financial performance across companies and over time to aid in evaluating investments in companies' debt or equity. Course credit will not be awarded for both ACIS 3115 and ACIS 4194.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4214 - Cost Planning and Control (3 credits)
The purpose of this course is to help the student develop an understanding of the role of accounting in the management process, an understanding of cost accounting systems, an understanding of cost behavior, an understanding of alternative accounting systems, and the usefulness of costs involved in non-routine decision-making.
Prerequisite(s): ACIS 2116 and ACIS 2504 and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4344 - Tax for Financial Planners (3 credits)
Overviews income tax concepts relevant to financial planning for individuals who are investors, employees, and business owners. Topics include income tax fundamentals for individuals, taxation of the sale of property, taxation of business entities, taxation of trusts, and overview of the federal transfer tax on estates and gifts. Duplicates some material in ACIS 4314. Course credit will not be awarded for both ACIS 4314 and ACIS 4344.
Prerequisite(s): FIN 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4364 - Taxation of Business Operations (3 credits)
Introduction to the tax issues for various operating models. Analysis from a tax perspective of formation, operation, distribution of earnings, business unit acquisitions and divestitures, and liquidation. Entity types discussed include partnerships, S Corporations, regular (C) Corporations and not for profit entities. Emphasis on how to report tax results to the applicable government(s) as well as the GAAP accounting of the tax results. Initial exposure to multistate taxation, the U.S. taxation of non-US activities, and estate and gift taxation.
Prerequisite(s): ACIS 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4414 - Financial Statement Auditing (3 credits)
Study of external financial statement auditing, professional code of conduct, audit evidence considerations, internal control, fraud, and transaction cycles, and audit reporting.
Prerequisite(s): ACIS 3115 and ACIS 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4444 - Forensic Accounting (3 credits)
This course provides students experience in forensic accounting, commonly used computer forensic software, forensic techniques, litigation support, fraud risk management, fraud investigation, and the related audit tools.
Prerequisite(s): ACIS 3115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4454 - Artificial Intelligence in Accounting and Auditing (3 credits)
An introduction to Artificial Intelligence to address real-world problems in accounting and auditing. Receive hands-on experience applying AI tools and processes used in auditing and assurance through class discussions, case analyses, and projects. Topics covered include the application of AI tools for analysis of financial data and internal controls. Obtain a base level understanding of how to use AI in audit and business settings, how to evaluate the impact of AI use on audit quality, and how client use of AI impacts audit risk. Overview of client confidentiality, ethics, opportunities, limitations, and challenges associated with the use of AI in auditing settings.
Prerequisite(s): ACIS 4414 and ACIS 3115 and ACIS 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4514 - Database Management Systems (3 credits)
Introduction to database management systems and their use in business. Topics covered include data modeling, normalization, SQL, transaction management and concurrency control, security issues, physical data organization, query optimization, hierarchical queries, distributed database management systems, object-oriented databases, client/server databases, multidimensional databases, data mining, data warehousing, and database administration.
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4544 - Applied Accounting Analytics (3 credits)
Application of analytics software and methodologies to address real-world based accounting activities. Examination of accounting scenarios to determine an appropriate analytic approach. Emphasis on commonly used accounting analytics software to apply the extract, transform, and load process on data. Implementation of analytics software to analyze accounting data, and evaluation and communication of the results through data visualizations.
Prerequisite(s): ACIS 2504 and ACIS 3115
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4654 - Accounting Analytics (3 credits)
Design and development of accounting systems using relational database management tools. Extraction and analysis of accounting data using queries, analytics, and visualization techniques. Application of accounting data analytics concepts using commercially available tools such as audit management software and current visualization tools. Proper preparation of data and use of analytics algorithms and visualization techniques to inform decision making.
Prerequisite(s): ACIS 2504 and ACIS 3504 and ACIS 3115
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4664 - Sustainability Accounting (3 credits)
Introduction to procedures for extracting and quantifying quality of corporate sustainability information and assessment of compliance with current accounting standards. Analysis of corporate sustainability data and impact on Financial Statements for corporate environmental and social justice decision-making. Introduction and differentiation of U.S. and international regulatory bodies promulgating sustainability standards. Discussion of disclosure components, frameworks, and standards concerning accounting and business-related sustainability information. Exploration of incremental decision usefulness of sustainability information for various stakeholders beyond traditional accounting financial statements. Presentation of attestation and assurance methodologies related to disclosed corporate sustainability accounting information.
Prerequisite(s): ACIS 3115 and ACIS 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4684 - Information Systems Security and Assurance (3 credits)
An examination of the concepts, technologies, and applications of security and assurance in information systems. Topics include the security threats against information systems; tools used by intruders; computing platforms and security; encryption; securing the transaction and the server; audit tools to detect intrusions; responses to attacks; legal, ethical and international issues; and the future of information systems security and assurance.
Instructional Contact Hours: (3 Lec, 3 Crd)

ACIS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ACIS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ACIS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ACIS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Business Information Technology

Our Website (http://www.bit.vt.edu/)

Overview

The Department of Business Information Technology offers an undergraduate major in business information technology with options in computer-based decision support systems, operations and supply chain management, and cybersecurity management and analytics. The department also offers and staffs business courses such as business analytics and modeling, systems analysis, database management, and data governance, privacy and ethics. Specific Business Information Technology (BIT) courses are listed below.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment.

Business Information Technology

The curriculum in business information technology is designed to provide the student with expertise in the quantitative and technological aspects of management, specifically the extensive use of computers for solving business problems and making managerial decisions. The name business information technology implies the application of scientific principles and techniques, mathematics, and computing to the management function with the objective of increased efficiency and productivity. Thus, the student of business information technology not only learns various quantitative techniques and models to apply to managerial problems, but also a logical and scientific approach to managerial decision-making. The curriculum provides training both for individuals interested in pursuing careers in business or government and for individuals interested in pursuing graduate or professional degrees. Students majoring in business information technology may choose one of three options reflecting their particular career objectives and interests.

Option I - Decision Support Systems (BIT-DSS)

This option educates the student in the design, implementation, and use of computerized information systems, decision support systems, and artificial intelligence to support contemporary business managers in the decision-making process. Special emphasis is placed on increased productivity and effectiveness through the use of models, quantitative data, and analytics embedded within a computerized decision support system. Graduates of this program will be prepared to pursue careers in business and industry where information technology, data analytics and computer-aided decision-making is an essential component of the managerial function.

Option II - Operations and Supply Chain Management (BIT-OSM)

This option educates students in the management of activities directly related to the creation and distribution of goods and services. The curriculum of Option II is designed to provide students with expertise in the planning and control of business processes within a firm and across its global supply chain. Emphasis is placed on applying IT, analytics and process analysis skills to improve the quality and productivity of business firms and their supply chain partners. Graduates of this program will be prepared to pursue careers as operations managers, business process managers, project managers, supply chain analysts, and quality, logistics, inventory or procurement managers in business, industry, and government.

Cybersecurity Management and Analytics Major (BIT-Cyber for Northern Virginia)

This option emphasizes business processes and data analytics as applied to cybersecurity management. BIT-Cyber students will gain proficiency in the business management of cybersecurity within an organization, including knowledge management, setting cyber policies, risk management, incident business response, using data to understand attacks on business assets, and overall management of the cybersecurity function within a business. Graduates of the program will be prepared for jobs as analysts, auditors, managers and planners within the cybersecurity function.

- Business Information Technology Major with Computer-Based Decision Support Systems Option (p. 670)
- Business Information Technology Major with Operations and Supply Chain Management Option (p. 673)
- Cybersecurity Management and Analytics Major (p. 676)

Head: Q.J. Nottingham
Arthur Andersen & Co Alumni Professor: A. Wang
R. B. Pamplin Professor of Management Science: C.W. Zobel
Sonny Merryman Professor of Business Information Technology: L.Z. Khansa
Suzanne Parker Thornhill Professor of Business Information Technology: P.B. Lowry
Verizon Professor of Business Information Technology: V. Venkatesh
Professors: P. Ghandforoush, T.L. James, R.S. Russell, A.O. Vance, A.G. Wang
Associate Professors: A.S. Abrahams, I. Adjerid, J.K. Deane, B.J. Hoopes, Q.J. Nottingham, O. Seref
Assistant Professors: R. Aljafari, M.M. Gordon, A.Jang, J. Liu V. Mindel and W. Shen
Collegiate Professor: M.M.H. Seref, D.G. Simpson
Collegiate Associate Professor: A .Arnette, W.H. Baker, , J.M. Teets
Collegiate Assistant Professor: H. Zhang
Associate Professor of Practice: B.M. Fraticelli, J. Sudweeks
Assistant Professors of Practice: M. Flora, J.D. Kern, J.W. Monday, R. Raman, D.C. Simundza
Senior Instructor: L.L. Clark
Assistant Director of BIT-Cyber Program in Northern Virginia: K. Wrightsman
Career Advisor: Q.J. Nottingham (540-231-6596)

Undergraduate Course Descriptions (BIT)

BIT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 2104 - Careers in Business Information Technology (1 credit)
Career opportunities and job search strategies in the business information technology and operations fields with reference to the BIT courses that best help the student identify a career in his/her selected field. Includes career skills development and resume writing. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIT 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 2164, PSCI 2164

BIT 2405 - Introduction to Business Statistics, Analytics, and Modeling (3 credits)
Introduction to basic statistical (inference) tools, analytics techniques, and modeling necessary in managerial decision-making. The decision-making aspect of the course, while utilizing quantitative/computational thinking, will emphasize ethical reasoning. Topics include, but are not limited to, descriptive statistics, elementary probability theory, sampling and sampling distributions, portfolio management, hypothesis testing, regression analysis, analysis of variance, big data, and data analytics.
Prerequisite(s): MATH 1524 or (MATH 1225 and MATH 1226)
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2406 - Introduction to Business Statistics, Analytics, and Modeling (3 credits)
Overview of analytic models and solution techniques in decision science. Discussion of descriptive and predictive analytics goals and methods. In addition to overview of mathematical modeling and solution techniques, discussions will include considerations of adapting analytics methods to various global and ethical business applications. Students should develop skills and appreciation of the use of data and analytics for problem solving.
Prerequisite(s): BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2554 - Linux, Shell Scripting, and Securing the OS for Business (3 credits)
Build foundational knowledge of the Linux operating system and file system concepts necessary for cybersecurity business professionals. Discuss the purpose, use, architecture, and navigation of the Linux file system. Build skill using a command line operating system for system administration and security management tasks. Employ file and directory management, process management, text manipulation, and permissions in the Linux operating system. Create shell scripts for process automation, configuration and process management, and security applications. Hands-on experience securing and hardening the Linux operating system.
Prerequisite(s): BIT 2405
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop information technology or operations management related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

BIT 3414 - Operations and Supply Chain Management (3 credits)
Study of the process directly related to the creation and distribution of goods and services. Increasingly, these operations are taking place outside the boundaries of a traditional enterprise. This course teaches students how to analyze processes, ensure quality, create value, and manage the flow of information, products and services across a network of customers, enterprises and supply chain partners.
Prerequisite(s): BIT 2406 and ACIS 2116 and ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3424 - Introduction to Business Analytics Modeling (3 credits)
Introduction of modeling of problems encountered in business analytics. Statistical and optimization modeling, computer solution, and analysis of business problems. Uses spreadsheet and database software to facilitate the modeling and solution of these problems.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3434 - Advanced Modeling for Business Analytics (3 credits)
Study of selected, advanced topics in decision modeling and business analytics. Emphasis on model formulation, solution techniques, interpretation of results and comprehensive approaches to problem-solving. Integer, multi-criteria, and non-linear programming as well as network analysis and heuristics. Includes case studies and use of Excel as the primary analytical tool.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3444 - Advanced Business Computing and Applications (3 credits)
Study of selected advanced topics in business computing. Construction of business applications using an advanced application development environment such as Visual Studio.net. Coverage of computer terminology, HTML, and Internet applications. The course builds computer literacy and strong programming skills. Junior standing required.
Prerequisite(s): BIT 3424 and (CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3454 - Business Process Improvement (3 credits)
Examines the technical aspects of business process improvement focusing on improvement strategies, quality control, data analysis and mining, and maturity models. Emphasizes analytical techniques for business process design, control, and improvement.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3464 - Enterprise Planning and Control Systems (3 credits)
The study of the design, analysis and implementation of enterprise-wide resource planning and control systems. The course examines decision support models for production planning, master scheduling, inventory control, shop floor control and related topics in planning and control. The course emphasizes the application of information technologies such as ERP, MRPII, CIM to operations planning and control.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3474 - Data Management and Business Analytics in Python (3 credits)
Python for data wrangling and data analysis to support business decisions. Illustrate proficiency in Python, basic skills such as variables, functions, conditionals, loops, libraries, and data structures. Leverage Python skills to learn how to manage data. Learn how to clean, transform, and augment data, as well as how to use Python to obtain data, in particular to work with application programming interfaces (APIs) and do web scraping. Learn how to use Python to conduct data analysis and for plotting and visualization of data. Apply Python for time series data analysis and data modeling using libraries.
Prerequisite(s): CS 1064 and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3484 - Advanced Business Analytics in Python and R (3 credits)
Python and R for advanced data analysis, including predictive analytics and machine learning, to support business decisions. Use Python and R to conduct exploratory data analysis. Learn how to handle data, sampling distributions, statistical experiments, and significance testing in Python and R. Apply simple and multiple linear regression and related concepts such as confidence intervals, dummy variables, correlation, multicollinearity, confounding variables, interactions and main effects, and outliers. Learn how to apply classification, specifically NaÏve Bayes, discriminant analysis, and logistic regression. Learn how to apply model evaluation techniques such as ROC curves, AUC, and lift. Introduction to and application of machine learning, including k-nearest neighbors, tree models, principal component analysis, and hierarchical clustering.
Prerequisite(s): BIT 3474
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3514 - Systems Analysis (3 credits)
Study of the current technologies for designing and developing computer-based business systems. Topics will include process, structural, behavioral, and conceptual data modeling methodologies such as Uniform Modeling Language (UML) and important design-related issues such as data flows and system capabilities. Design issues will be explored through class projects. This course duplicates BIT 4524.
Prerequisite(s): CS 1054 or CS 1064 or CS 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3524 - Database Management and Design (3 credits)
Study of the design of databases and data structures for supporting business applications. Basic database structure and design, structured query language, database management systems, integration of backend database servers, data warehousing and mining, on-line analytical processing, and database application, security, and management. This course duplicates BIT 4514.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3554 - Networks, Telecommunications and Security (3 credits)
Provides an introduction to computer networks and data communications in business. Topics include mechanisms for reliable data transfer, network topologies and technologies, and a comprehensive treatment of inter-networking. Additional topics include packet switching, and cloud, edge, and advanced networking. Security issues related to using computer networks are discussed, along with network design issues, and methodologies for network applications. Duplicates BIT 4554.
Prerequisite(s): BIT 2405 or ACIS 3504 or BIT 2164 or CS 2164 or PSCI 2164
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ACIS 3554

BIT 3614 - Election Security (3 credits)
Election system and historical voting in the U.S., their inherent vulnerabilities, and how to locate and prepare against poor election security practices. Trust and cultural significance of voting in a democratic America. The election system security standards and regulations including the Virginia Department of Elections Voting Systems Security Policies, Standards, Guidelines, and Locality Election Security Standards (LESS). Threats, vulnerabilities, and attacks on election infrastructures and how they may be evaluated and mitigated. Security controls for voting systems, voter registration databases, and associated IT infrastructure and systems used to manage elections while exploring cybersecurity careers in the public sector. Prepares selected students for a summer internship supporting the Cyber Navigator Program with a specific Virginia Locality. Primarily designed for students majoring or minoring in cybersecurity, the course is open to all students of any major.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3664 - Cybersecurity Management I (3 credits)
Focuses on building general cybersecurity knowledge with an emphasis on cybersecurity management. This course will teach students about the categories of security controls. Students will be introduced to the necessity of cybersecurity through an introduction to cybersecurity concepts (e.g., threats, vulnerabilities, risk) and using basic tools to identify cybersecurity weaknesses (security assessments, passive and active reconnaissance, and vulnerability scanning). Students will learn about security policies and risk assessments and will perform a risk assessment. Students will be introduced to types of social engineering and malware tools and techniques. This class will introduce the legal and ethical aspects of security and privacy and the tools used to protect data privacy. Students will also learn to develop policies and procedures to manage hosts and explore how to harden one. This course will also introduce students to the management of internet of things (IOT) and cloud technologies, human resources security, incident response and forensics, physical and infrastructure security, and cybersecurity resilience.
Prerequisite(s): BIT 2554 and (BIT 3554 or ACIS 3554)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3674 - Cybersecurity Management II (3 credits)
Focuses on building general cybersecurity knowledge with an emphasis on the management and implementation of technical cybersecurity controls. This course will build knowledge of and teach students how to implement symmetric and asymmetric encryption. Students will learn about authentication and access controls and how to implement them, as well as understand and implement the network security protocols, standards, and applications that help support them. The course will also teach students how about database security practices and how to implement them, as well as build their understanding of firewalls, intrusion detection and prevention, buffer overflows, software security, wireless network security, and mobile security.
Prerequisite(s): BIT 3664
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4164, PSCI 4164

BIT 4424 - Business Information Visualization and Analytics (3 credits)
Basic perception and design principles and techniques for information visualization, with an emphasis on the application of visualization software for data exploration and the development of analytical skills for business. Includes hands-on exposure to information visualization and statistical software.
Prerequisite(s): BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4434 - Computer Simulation in Business (3 credits)
In-depth study of the application of computer simulation techniques to business decision making and process improvement. The theory of computer simulation and statistical analysis of results are included. Attention is focused on using simulation software stressing application to specific problems.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4444 - Web-Based Decision Support Systems (3 credits)
Study of current technologies for designing and constructing interactive, Internet-based systems for supporting business decisions. Topics may include the operation of the Internet, server-side programming, client-side programming, server-side scripting, XML, XHTML, database integration, COM, CGI, and others. Design issues will be explored through a class project.
Prerequisite(s): BIT 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4454 - Business Analysis Seminar in IT (3 credits)
Comprehensive treatment of Decision Support Systems (DSS) as managerial tools, particularly in an e-commerce environment. Emphasis is at the builder and user level. A primary emphasis is on problem solving through the integration of various quantitative techniques as well as on IT concepts. The course includes a comprehensive project using state-of-the-art software.
Prerequisite(s): BIT 3434 and BIT 4444 and BIT 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4464 - Advanced Supply Chain Management (3 credits)
Advanced study of efficient methods for streamlining the production and delivery of products and services across functions, enterprises and global boundaries. Topics include the facilities, functions, technologies, and activities involved in creating and delivering products and services, especially in a digital marketplace. Designing and managing a network of suppliers across enterprises is discussed, along with the information systems, risk management and planning issues involved.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4474 - Global Operations and Information Technology (3 credits)
This course includes concepts and issues critical in the globalization of business operations and information technology. Topics covered include the organization of global operations, cultural and national comparisons, planning global operations, facilities location, product development, technology transfer, global communication links, transborder data flow, international information systems, and other emerging operations and information technology issues.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4484 - Project Management (3 credits)
Study of efficient methods for planning and controlling projects. Topics include project management and scheduling tools, project quality assurance, risk and cost control, resource constrained scheduling, definition and requirements analysis, task integration, and managing alliances. The application of information technology to project management and control is emphasized throughout the course.
Prerequisite(s): BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4544 - Artificial Intelligence, Machine Learning, and Deep Learning in BIT (3 credits)
Learn concepts and techniques related to artificial intelligence (AI), machine learning (ML), and deep learning (DL). Learn the fundamentals of AI, ML, and DL algorithms and how to apply them to problems of interest to majors in the business information technology (BIT) department. Understand and apply supervised (classification, regression) and unsupervised (clustering) machine learning, and applications of these techniques in business. Apply deep learning, for example, recurrent neural networks (RNN), generative adversarial networks (GAN), and convolutional neural networks (CNN).
Prerequisite(s): BIT 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4604 - Data Governance, Privacy and Ethics (3 credits)
Examination of data analytics and automated decision making issues, across multiple technology contexts, through the lens of the humanities and ethics. Privacy, autonomy, data ownership, equality, and accountability. Decision making and exploration of questions of data ethics and data fairness throughout the data life cycle.
Prerequisite(s): BIT 2405 or CMDA 2014 or CS 1114 or CS 1054 or CS 1064
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4624 - Cybersecurity Analytics for Business (3 credits)
Application of advanced analytics to cybersecurity in a business setting. Categorization of cyber threats and solutions. Data mining, visualization and machine learning applied to large data sets for anomaly detection, threat prediction, and incident response analysis. Investigation of adversarial machine learning. Selection of appropriate analytics techniques and security platforms. Consideration of business and ethical issues.
Prerequisite(s): BIT 3674 or BIT 4614 or CS 4264
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4644 - Digital Forensics and Incident Response Management (3 credits)
Focuses on building knowledge about the field of digital forensics and incident response. Students will learn about cybercrime and the digital forensics process. The course will build knowledge of, and teach students how to implement, digital forensics techniques and tools. Students will learn about file systems, and how to work with Windows, Linux, and Macintosh file systems and forensic tools to acquire and analyze forensic evidence. Students will learn how to apply forensic tools and techniques to network, mobile, internet of things (IOT), cloud, email, social media, and dark web data and services. The course will also build knowledge about how to manage incident response capabilities such as computer security incident response teams (CSIRTs), incident response planning, guidance for processing crime and incident scenes, and how to compile forensic reports and integrate forensically obtained knowledge into future incident response planning.
Prerequisite(s): BIT 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4654 - Penetration Testing and Ethical Hacking for Business (3 credits)
Focuses on building competence in penetration testing for business. This course will teach principles of ethical hacking, such as system reconnaissance, enumeration, vulnerability scanning, and exploitation. Students will learn how to find and exploit vulnerabilities in web applications, operating systems, wireless networks, as well as perform social engineering and physical security assessments. Students will also perform penetration tests and learn to write reports for managerial audiences.
Prerequisite(s): BIT 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

BIT 4854 - Analytics in Action (3 credits)
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations.
Corequisite(s): BDS 2005, CMDA 2014
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 4854

BIT 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Business Information Technology Major with Computer-Based Decision Support Systems Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
BIT 2104	Careers in Business Information Technology	1
BIT 3424	Introduction to Business Analytics Modeling [#]	3
BIT 3434	Advanced Modeling for Business Analytics [#]	3
BIT 3444	Advanced Business Computing and Applications [#]	3
BIT 4484	Project Management [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Select one of the following:		3
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Subtotal		31
Option Required Courses		
BIT 3514	Systems Analysis [#]	3
BIT 3524	Database Management and Design [#]	3
BIT/ACIS 3554	Networks, Telecommunications and Security [#]	3
BIT 4444	Web-Based Decision Support Systems [#]	3
BIT 4454	Business Analysis Seminar in IT [#]	3
BIT DSS Elective [#]		*3*
Subtotal		18
Free Electives		
Select nine credit hours of Free Electives		9
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	

Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [3]		3
Subtotal		46
Total Credits		**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

BIT DSS Electives

Code	Title	Credits
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business #	3
BIT 3454	Business Process Improvement #	3
BIT 3464	Enterprise Planning and Control Systems #	3
BIT 3474	Data Management and Business Analytics in Python #	3
BIT 3484	Advanced Business Analytics in Python and R #	3
BIT 3664	Cybersecurity Management I #	3
BIT 3674	Cybersecurity Management II #	3
BIT 4424	Business Information Visualization and Analytics #	3
BIT 4434	Computer Simulation in Business #	3
BIT 4464	Advanced Supply Chain Management #	3
BIT 4474	Global Operations and Information Technology #	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT #	3
BIT 4604	Data Governance, Privacy and Ethics #	3
BIT 4624	Cybersecurity Analytics for Business #	3
BIT 4854	Analytics in Action #	3

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation . Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs .

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps.html).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
BIT 2104	Careers in Business Information Technology	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select one of the following:		3
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
BIT 3414	Operations and Supply Chain Management [2,#]	3
BIT 3424	Introduction to Business Analytics Modeling [#]	3
HTM/MGT 2314	Introduction to International Business [2]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Third Year		
Fall Semester		
BIT 3434	Advanced Modeling for Business Analytics [#]	3
BIT 3444	Advanced Business Computing and Applications [#]	3
BIT 3514	Systems Analysis [#]	3
MKTG 3104	Marketing Management [2,#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
BIT 4444	Web-Based Decision Support Systems [#]	3
BIT 3524	Database Management and Design [#]	3
BIT 4484	Project Management [#]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
BIT/ACIS 3554	Networks, Telecommunications and Security [#]	3
BIT 4454	Business Analysis Seminar in IT [#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Elective		3
	Credits	**15**
Spring Semester		
BIT DSS Elective [#]		3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [3]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

BIT DSS Electives

Code	Title	Credits
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business [#]	3
BIT 3454	Business Process Improvement [#]	3
BIT 3464	Enterprise Planning and Control Systems [#]	3
BIT 3474	Data Management and Business Analytics in Python [#]	3
BIT 3484	Advanced Business Analytics in Python and R [#]	3
BIT 3664	Cybersecurity Management I [#]	3
BIT 3674	Cybersecurity Management II [#]	3
BIT 4424	Business Information Visualization and Analytics [#]	3
BIT 4434	Computer Simulation in Business [#]	3
BIT 4464	Advanced Supply Chain Management [#]	3
BIT 4474	Global Operations and Information Technology [#]	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT [#]	3
BIT 4604	Data Governance, Privacy and Ethics [#]	3
BIT 4624	Cybersecurity Analytics for Business [#]	3
BIT 4854	Analytics in Action [#]	3

[1] **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] **Graduation Requirement**: Students must achieve a **grade of C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business/MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as Pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

BIT DSS Elective

Code	Title	Credits
BIT 3454	Business Process Improvement	3
BIT 3464	Enterprise Planning and Control Systems	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4464	Advanced Supply Chain Management	3
BIT 4474	Global Operations and Information Technology	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614		3
BIT 4624	Cybersecurity Analytics for Business	3

Business Information Technology Major with Operations and Supply Chain Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
BIT 2104	Careers in Business Information Technology	1
BIT 3424	Introduction to Business Analytics Modeling [#]	3
BIT 3434	Advanced Modeling for Business Analytics [#]	3
BIT 4484	Project Management [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Select one of the following:		3
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Subtotal		28
Option Required Courses		
BIT 3454	Business Process Improvement [#]	3
BIT 3464	Enterprise Planning and Control Systems [#]	3
BIT 4434	Computer Simulation in Business [#]	3

BIT 4464	Advanced Supply Chain Management #	3
BIT 4474	Global Operations and Information Technology #	3
BIT OSM Elective #		
Select two courses from the BIT OSM Electives list below. #		6
Subtotal		21
Free Electives		
Select nine credit hours of Free Electives		9
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [3]		3
Subtotal		46
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

BIT OSM Electives

Code	Title	Credits
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business #	3
BIT 3444	Advanced Business Computing and Applications #	3
BIT 3514	Systems Analysis #	3
BIT 3524	Database Management and Design #	3
BIT 3474	Data Management and Business Analytics in Python #	3
BIT 3484	Advanced Business Analytics in Python and R #	3
BIT/ACIS 3554	Networks, Telecommunications and Security #	3
BIT 3664	Cybersecurity Management I #	3
BIT 3674	Cybersecurity Management II #	3
BIT 4424	Business Information Visualization and Analytics #	3
BIT 4444	Web-Based Decision Support Systems #	3
BIT 4454	Business Analysis Seminar in IT #	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT #	3
BIT 4604	Data Governance, Privacy and Ethics #	3
BIT 4624	Cybersecurity Analytics for Business #	3
BIT 4854	Analytics in Action #	3

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
BIT 2104	Careers in Business Information Technology	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select one of the following:		3
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
BIT 3414	Operations and Supply Chain Management [2,#]	3
BIT 3424	Introduction to Business Analytics Modeling [#]	3
HTM/MGT 2314	Introduction to International Business [2]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Third Year		
Fall Semester		
BIT 3434	Advanced Modeling for Business Analytics [#]	3
FIN 3104	Introduction to Finance [2,#]	3
BIT 3454	Business Process Improvement [#]	3
MKTG 3104	Marketing Management [2,#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
BIT 3464	Enterprise Planning and Control Systems [#]	3
BIT 4434	Computer Simulation in Business [#]	3
BIT 4484	Project Management [#]	3
BIT 4464	Advanced Supply Chain Management [#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Fourth Year		
Fall Semester		
BIT OSM Elective [#]		3
BIT 4474	Global Operations and Information Technology [#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Free Elective		3
	Credits	**15**
Spring Semester		
BIT OSM Elective [#]		3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or free elective [3]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

BIT OSM Electives

Code	Title	Credits
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business #	3
BIT 3444	Advanced Business Computing and Applications #	3
BIT 3514	Systems Analysis #	3
BIT 3524	Database Management and Design #	3
BIT 3474	Data Management and Business Analytics in Python #	3
BIT 3484	Advanced Business Analytics in Python and R #	3
BIT/ACIS 3554	Networks, Telecommunications and Security #	3
BIT 3664	Cybersecurity Management I #	3
BIT 3674	Cybersecurity Management II #	3
BIT 4424	Business Information Visualization and Analytics #	3
BIT 4444	Web-Based Decision Support Systems #	3
BIT 4454	Business Analysis Seminar in IT #	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT #	3
BIT 4604	Data Governance, Privacy and Ethics #	3
BIT 4624	Cybersecurity Analytics for Business #	3
BIT 4854	Analytics in Action #	3

[1] **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] **Graduation Requirement**: Students must achieve a **grade of C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business/MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

[4] **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

[5] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as Pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

BIT OSM Electives

Code	Title	Credits
BIT 3514	Systems Analysis [1,2]	3
BIT 3524	Database Management and Design [1,2]	3
BIT/ACIS 3554	Networks, Telecommunications and Security [1,2]	3
BIT 4424	Business Information Visualization and Analytics [1,2]	3
BIT 4444	Web-Based Decision Support Systems [1,2]	3
BIT 4454	Business Analysis Seminar in IT [1,2]	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT [1,2]	3
BIT 4604	Data Governance, Privacy and Ethics [1,2]	3
BIT 4614	[1,2]	3
BIT 4624	Cybersecurity Analytics for Business [1,2]	3

[1] **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

[2] **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

Cybersecurity Management and Analytics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3

FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
BIT 2104	Careers in Business Information Technology	1
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business [#]	3
BIT 3474	Data Management and Business Analytics in Python [#]	3
BIT 3484	Advanced Business Analytics in Python and R [#]	3
BIT/ACIS 3554	Networks, Telecommunications and Security [#]	3
BIT 3664	Cybersecurity Management I [#]	3
BIT 3674	Cybersecurity Management II [#]	3
BIT 4484	Project Management [#]	3
BIT 4644	Digital Forensics and Incident Response Management [#]	3
BIT 4654	Penetration Testing and Ethical Hacking for Business [#]	3
BIT 4964	Field Study [3,#]	3
CS 1064	Introduction to Programming in Python	3
FIN 4014	Cyberlaw and Policy [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
CMA Electives [#]		
Select two courses from the CMA electives list.		6
Subtotal		58
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Electives [4]		3
Subtotal		46
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling,ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 BIT 4964 (Field Study) eligibility requirement: 2.5 minimum overall GPA. Each student is responsible for acquiring an appropriate internship. Enrollment in the field study course requires approval of the BIT field study coordinator. More information is available at https://bit.vt.edu/academics/undergraduate-programs/cyber/internship.html

4 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in- major GPA are noted with a # footnote.

CMA Electives

Code	Title	Credits
ACIS 4684	Information Systems Security and Assurance [#]	3
BIT 3514	Systems Analysis [#]	3
BIT 3524	Database Management and Design [#]	3
BIT 4424	Business Information Visualization and Analytics [#]	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT [#]	3
BIT 4604	Data Governance, Privacy and Ethics [#]	3
BIT 4624	Cybersecurity Analytics for Business [#]	3
CS 4264	Principles of Computer Security [#]	3
MATH 4175	Cryptography [#]	3
BIT/PSCI/CS 2164	Foundations of Contemporary Security Environments [#]	3
BIT/PSCI/CS 4164	Future of Security: Integrative Solutions for Complex Security Systems [#]	3

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (https://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
BIT 2104	Careers in Business Information Technology	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
CS 1064	Introduction to Programming in Python	3
BIT 2554	Linux, Shell Scripting, and Securing the OS for Business [#]	3
BIT/ACIS 3554	Networks, Telecommunications and Security [#]	3
	Credits	**18**
Spring Semester		
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
BIT 3474	Data Management and Business Analytics in Python [#]	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
BIT 3664	Cybersecurity Management I [#]	3
	Credits	**15**
Third Year		
Fall Semester		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
BIT 3674	Cybersecurity Management II [#]	3
BIT 3484	Advanced Business Analytics in Python and R [#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
	Credits	**15**
Spring Semester		
BIT 4644	Digital Forensics and Incident Response Management [#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
CMA Elective [#]		3
	Credits	**15**

Fourth Year		
Fall Semester		
CMA Elective [#]		3
FIN 4014	Cyberlaw and Policy [#]	3
BIT 4484	Project Management [#]	3
BIT 4654	Penetration Testing and Ethical Hacking for Business [#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
BIT 4964	Field Study (approval required) [3,#]	3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Electives [4]		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling,ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 BIT 4964 (Field Study) eligibility requirement: 2.5 minimum overall GPA. Each student is responsible for acquiring an appropriate internship. Enrollment in the field study course requires approval of the BIT field study coordinator. More information is available at https://bit.vt.edu/academics/undergraduate-programs/cyber/internship.html

4 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in- major GPA are noted with a # footnote.

CMA Electives

Code	Title	Credits
ACIS 4684	Information Systems Security and Assurance [#]	3
BIT 3514	Systems Analysis [#]	3
BIT 3524	Database Management and Design [#]	3
BIT 4424	Business Information Visualization and Analytics [#]	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT [#]	3
BIT 4604	Data Governance, Privacy and Ethics [#]	3
BIT 4624	Cybersecurity Analytics for Business [#]	3
CS 4264	Principles of Computer Security [#]	3
MATH 4175	Cryptography [#]	3
BIT/PSCI/CS 2164	Foundations of Contemporary Security Environments [#]	3
BIT/PSCI/CS 4164	Future of Security: Integrative Solutions for Complex Security Systems [#]	3

Finance, Insurance, and Business Law

Our Website (http://www.finance.pamplin.vt.edu)

E-mail: fin@vt.edu

Overview

Finance is a specialty that works with the development, allocation and use of monetary resources within established legal and ethical frameworks, while understanding and mitigating the associated risks. Money is a critical component of the economic system and its flow is the sustaining force of the U.S. and global economy. Therefore, in working with how governments, corporations, intermediaries, and households utilize their financial assets finance professionals are an integral part of how the economy perpetuates the standard of living that we enjoy.

Traditionally there are three separate but related fields within finance:

1. corporate financial management or "business finance" which focuses on the internal decisions of companies to raise funds and invest in corporate assets;
2. investment management which focuses on the purchase and sale of stocks and bonds or their derivatives by individuals and institutions; and
3. financial services management, which focuses on the management and regulation of institutions and the role that financial institutions play in the economy.

The undergraduate program in Finance meets the requirements of students who desire specialized careers in financial management. Students gain expertise in finance, analytics, and accounting that are essential for success as a financial professional. The case-oriented focus of coursework requires students to apply their knowledge and strengthen their oral and written communication skills. The department offers majors in Finance, Financial Planning and Wealth Management, FinTech and Big Data Analytics, and Real Estate Finance. Students in the

Finance major select one or more options among Corporate Financial Management, Financial Accounting, Financial Risk Management, or Investment Management and Chartered Financial Analyst (CFA).

The curriculum offers courses in finance, insurance, and business law, but majors only in finance-related fields of study.

Degree Requirements

Students declare their major in Finance or one of three specialized finance majors:

- Financial Planning and Wealth Management
- FinTech and Big Data Analytics
- Real Estate Finance (double-major required)

Students who pursue a Finance major select different combinations of elective courses to fulfill the requirements of one or more of the four options offered. The four options are:

- Corporate Financial Management
- Financial Accounting
- Financial Risk Management
- Investment Management and Chartered Financial Analyst (CFA)

- Finance and Real Estate Major (p. 684)
- Finance Major with Corporate Financial Management Option (p. 687)
- Finance Major with Financial Accounting Option (p. 691)
- Finance Major with Financial Risk Management Option (p. 694)
- Finance Major with Investment Management and Chartered Financial Analyst Option (p. 697)
- Financial Planning and Wealth Management Major (p. 700)
- FinTech and Big Data Analytics Major (p. 703)

Head: Dr. Vijay Singal
Assistant Department Head: Cara Spicer
J. Gray Ferguson Professor of Finance: V. Singal
Alumni Distinguished Professor and R.B. Pamplin Professor of Finance: R. Kumar
Pamplin & Oliver Professor of Finance: G.B. Kadlec
R.V. and A.F. Oliver Professor of Investment Management: R. Kumar
Wells Fargo Professor in Financial Risk Management: S. Mansi
Emeritus Professors: J. Hiller, A. Keown, D. Klock, R. Lytton, G. Morgan, D. Patterson, J. Pinkerton, D. Shome, and G.R. Thompson
Associate Professors: R.S. Billingsley, J.C. Easterwood, R. Edelen, B. Paye and J. Xu
Assistant Professors: G. Leonard, M. Lithell, A. MacKinlay, A. Pecora, N. Tran, and P. Ye
Assistant Professors and Russell & Arlene Oliver Junior Faculty Fellows: T. Beason and F. Cabezón
Assistant Professor and Stephen & Karen Jones Junior Faculty Fellow: Y. Tellez
Visiting Assistant Professor: F. Hood
Professors of Practice: S. Beach, M. Kender, C. Kennedy, D. Rodriguez and C. Spicer
Associate Professor of Practice: B. Hart and J. Malone
Assistant Professors of Practice: W. Coleman, B. Hart, J. Lineberry, and E. Wikle
Adjunct Professors: D. Anderson, M. Fleenor, E. Johnsen, E. McClanahan, J. Powell, A. Price and J. Showalter

Undergraduate Course Descriptions (FIN)

FIN 2114 - Investments and Financial Literacy (3 credits)
Examines budgeting; taxes; long- and short-term borrowing; credit card debt; student loan debt; ethical issues in both lending and investments; insurance; the investment process; the financial markets; investing in common stock, bonds, and mutual funds; major financial decisions, and retirement planning. Coverage of time value of money and risk and return will provide fundamental tools for valuation and financial decision-making.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 2164 - Survey of Finance and Career Planning (1 credit)
Career opportunities and job search strategies in the finance field with reference to the finance courses that best help the student identify a career in his/her selected field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

FIN 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. Pre: Instructors consent and the completion of 30 SH with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

FIN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 3054 - Legal and Ethical Environment of Business (3 credits)
This course examines the legal and ethical environment in which businesses operate. Topics include legal systems, dispute resolution, torts, contracts, agency, employment, business forms, property, ethical theories, decision-making and other selected subjects. Emphasis is placed on problem solving through the application of principles and reasoned analysis. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3074 - Legal, Ethical, and Financing Issues for Entrepreneurs (3 credits)
Introduction of key legal, ethical, and financing topics for new ventures. Ethical decision making in entrepreneurial situations. Choosing among legal entities for financing and ownership goals. Company governance. Creating and protecting intellectual property. Identifying and choosing financing options for new ventures. Employment issues for entrepreneurial firms. Basics of contracts. Enterprise risk management and compliance. Exit strategies. Partially duplicates FIN 3054 (Legal and Ethical Environment of Business). Students may not receive credit for both courses. Sophomore Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3104 - Introduction to Finance (3 credits)
Overview of financial decision-making process focusing on the creation of wealth. Topics covered include the time value of money, how stocks and bonds are valued, financial decision-making within a firm, an overview of financial markets, and investment banking. The course is designed for finance and non-finance majors.
Prerequisite(s): (ACIS 2115 and ECON 2005 and BIT 2405) or (ACIS 2115 and ECON 2005 and CMDA 2005) or (ACIS 2115 and ECON 2005 and STAT 3005) or (ACIS 2115 and ECON 2005 and STAT 3604) or (ACIS 2115 and ECON 2005 and STAT 3615 and STAT 3616) or (ACIS 2115 and ECON 2005 and STAT 4604) or (ACIS 2115 and ECON 2005 and STAT 4705 and STAT 4706) or (ACIS 2115 and ECON 2025H and BIT 2405) or (ACIS 2115 and ECON 2025H and CMDA 2005) or (ACIS 2115 and ECON 2025H and STAT 3005) or (ACIS 2115 and ECON 2025H and STAT 3604) or (ACIS 2115 and ECON 2025H and STAT 3615 and STAT 3616) or (ACIS 2115 and ECON 2025H and STAT 4604) or (ACIS 2115 and ECON 2025H and STAT 4705 and STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3114 - Python/SQL for Data Analytics and Finance (3 credits)
A foundation in Python/SQL and the tools needed to implement a data-driven approach to financial problem solving. Emphasis on accessing external databases, merging databases, manipulating and transforming data, performing operations, generating an output or another dataset, and exporting in a readable or visual form. To prepare students to analyze datasets for making financial decisions.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3124 - Financial Planning for Professionals (3 credits)
Analysis of financial needs, from the context of the individual, household or small business owner, related to financial situation (cash management and use of debt), income taxes, risk management, retirement planning, investment planning, estate planning, and other special needs. Utilizes mathematical and computing skills. FIN 3134 may be taken prior to or concurrent with course. Sophomore Standing required.
Corequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3134 - Financial Analytics (3 credits)
This course provides an understanding of the theory and practice of making financial decisions for corporations through the understanding of relevant data and applying computational and statistical methodologies to decision making. Topics include the time value of money, risk and return, security valuation, and interest rate determination. Some key concepts and computational and statistical modeling are completed in Excel. Pre: Sophomore standing.
Prerequisite(s): FIN 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3144 - Investments: Debt, Equity and Derivatives (3 credits)
Risk, return and portfolio modeling theory, knowledge of financial securities and markets and the information and data contained within them. Introduction to mutual funds, financial securities, and markets. Application of financial computation and modeling through portfolio analysis, market efficiency and performance evaluation, bond valuation, term structure of interest rates, interest rate risk, security analysis and stock valuation, options, Black-Scholes option pricing model, and futures. Pre: Sophomore standing.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3154 - Corporate Financial Analytics and Strategy (3 credits)
This course provides the understanding of the types of financial management decisions that firms make, the environment in which decisions are made, the available choices and decision criteria, and valuation consequences of these choices through financial analytical modeling. Determination of a firm's optimal debt- equity ratio, estimation of cost of capital, evaluation of capital investments, payout policies, merger and acquisition decision-making, and sources of financing with emphasis on identifying and mitigating potential agency conflicts. Pre: Sophomore standing.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3174 - Finance Career Strategies (1 credit)
Analysis and research of career opportunities in financial industry. Study of future trends in careers in financial industry. Development of short and long-term career goals. Building and developing a professional network. Identify types of finance interviews. Ethical negotiation of job offers.
Instructional Contact Hours: (1 Lec, 1 Crd)

FIN 3204 - Risk and Insurance (3 credits)
Surveys the concept of risk as it applies to the nuclear family and as a socio-economic force in society. Risk management techniques utilizing social and proprietary insurance to neutralize the effect of risks inherent in daily life: termination or suspension of earnings, liability exposures, and potential losses of real and personal property values. Sophomore Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3254 - Credit Risk Analysis (3 credits)
Analysis of the risks inherent in credit/lending decisions. Pricing of loans, appropriate documentation, and monitoring of the creditworthiness of businesses and individuals. Emphasis on making credit decisions and structuring of credit agreements.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4004 - Wills, Trusts, and Estates (3 credits)
Examines the control of assets through the creation and use of trusts, and the control of property through estate planning. The course emphasizes financial planning through estate management both personally and as a part of a business plan.
Prerequisite(s): FIN 3054 or FIN 3074
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4014 - Cyberlaw and Policy (3 credits)
Cyber law, ethics, and policy in a changing world. National and international methods of regulation and protection of fundamental rights. Legal, ethical, and policy issues for Internet governance, speech, privacy, cybersecurity, surveillance, electronic commerce, intellectual property, and cyberwar. Examination of current issues and texts in light of fundamental ethical and legal principles and global discourse. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4024 - Legal and Regulatory Aspects of ESG (3 credits)
Examines the legal and regulatory issues raised by Environmental, Social, Governance (ESG) aspects of investments and corporate finance. Specific attention is given to ESG's effect upon traditional corporate law principles, reporting and regulatory frameworks.
Prerequisite(s): (FIN 3054 or FIN 3074) and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4104 - Retirement Planning (3 credits)
Overview of planning needs, products, and strategies used by financial professionals to help businesses, small business owners, and individuals choose and implement an effective retirement plan. Must have prerequisite or permission of instructor.
Prerequisite(s): (FIN 3124 and ACIS 4344) or (FIN 3134 and ACIS 3314)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4114 - Financial Planning Technology and Modeling (3 credits)
Use of professional software applications that support financial planning analyses, plan preparation, wealth management, and client relationships. Principles of personal investment portfolio research, construction, and performance applied to comprehensive financial planning and wealth management.
Prerequisite(s): FIN 3124 and FIN 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4124 - Client Relationship Management (3 credits)
Investigation of socio-psychological factors and communication/interviewing strategies that foster trust-based relationships essential to the success of financial advisors and other financial service professionals. Graduate students are expected to have completed AAEC 3104 or FIN 3124 or an equivalent course or may enroll with permission of the instructor.
Prerequisite(s): FIN 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4134 - Financial Planning Applications (3 credits)
Integration of financial planning content in the resolution of client situations in the context of ethical and compliant workplace practices. Utilizes a case analysis approach applying financial planning processes and procedures. Graduate students are expected to have similar background from equivalent courses or professional experience or may enroll by permission of the instructor. ACIS 4344 or FIN 4004 taken simultaneously with the course can be substituted for the prerequisites.
Prerequisite(s): FIN 3124 and FIN 3144 and FIN 3204 and ACIS 4344
Corequisite(s): FIN 4104, FIN 4114, FIN 4004
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4144 - International Financial Management (3 credits)
Explores the environmental challenges facing the financial manager of a multinational corporation and the tools and techniques developed to meet such challenges.
Prerequisite(s): FIN 3104 or FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4154 - Real Estate Finance (3 credits)
This course introduces the fundamentals of both real estate financing and investment. Conventional mortgages as well as more creative financing methods will be analyzed. The secondary market for mortgages and relevant institutional factors also will be examined. Investment analysis of real estate will be viewed in a capital budgeting framework; appropriate tax law will be discussed as it affects real estate cash flows.
Prerequisite(s): FIN 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4204 - Environmental, Social, and Governance Financial Analytics (3 credits)
Environmental, Social and Governance (ESG) factors impacting corporate investment and financing decisions. Analytical tools for incorporating ESG factors into various forms of financial analysis including capital budgeting, capital structure, financing decisions, and investment portfolio management.
Prerequisite(s): (FIN 3054 or FIN 3074) and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4214 - Financial Modeling in Excel (3 credits)
Concepts of finance applied to the construction of models in Excel. Construct models of financial statement to evaluate financial strategies for a firm; design risk/return models for investment portfolio strategies using equity and/or debt securities; build models to optimize bond portfolios including interest rate sensitivities, duration and convexity; develop models to analyze and dynamically hedge option and futures portfolios; assemble binomial tree models on American options; build simulation models to evaluate different types of options.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4224 - Fixed Income Securities: Analysis and Management (3 credits)
Analysis of fixed income securities, including corporate bonds, U.S. Treasury notes and bonds, municipal bonds, money market securities, and home mortgages. The analysis include interest rate risk, credit risk, bond valuation theory, and the valuation of embedded options in the bond contract. Theories of the term structure of interest rates are presented. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4225 - Analytics for Fixed Income Securities and Portfolio Management (3 credits)
4225: Management of fixed income securities in an experiential setting. Bond pricing and investment. Credit analysis and portfolio strategies in fixed income. Introduction to advanced analytical techniques in bond and portfolio analytics. Conduct research on individual companies, industries, and countries. Membership in BASIS (Bond And Securities Investing by Students). Must have a B- or better in prereq. Pass/Fail Only.
Prerequisite(s): FIN 3134
Corequisite(s): FIN 4224
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4226 - Analytics Fixed Inc. Port Mgmt (3 credits)
4226: Advanced management of fixed income portfolios in an experiential setting. Advanced credit analysis and modeling. Advanced analytical techniques for bonds and portfolios. Lead research teams. Research macroeconomic and international capital trends. Execute reports for internal and external distribution, especially for the clients. Membership in BASIS (Bond And Securities Investing by Students). Must have a B- or better in prereq. Pass/Fail Only.
Prerequisite(s): FIN 4224 and FIN 4225
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4234 - Venture Capital and Investment Banking (3 credits)
Explores the venture capital cycles of fund-raising, investing in portfolio firms, and exiting the investment. Focuses on the role of investment banking in the exiting of investments by taking the portfolio firms public through initial public offerings. Includes a conceptual component and an applied component in which the case method is used. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4244 - Asset Valuation and Corporate Governance (3 credits)
The effect of corporate governance on asset-valuation. Case oriented course focusing on the valuation of non-financial assets such as projects, business units, private and public firms. Topics include method of comparables, discounted cash flow methods and the real options approach to valuation. Examines the external and internal governance mechanisms for preserving and enhancing the value of a firm. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4254 - Bank Management and Financial Services (3 credits)
The functions of financial service providers and the risks inherent in the provision of banking and other financial services. Regulatory background and issues. Case oriented course. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4255 - Credit Corps Lending Practicum (3 credits)
Credit underwriting of commercial loans in an experiential setting. Project work spans two semesters. 4255: First project and basic management of cash flows on legacy portfolio of loans. Credit analysis of middle market companies leading to recommendations for lending to such companies. Research on individual companies, their industries, or on commercial real estate projects. Research on relative loan pricing, trends in leverage loan markets. Professional-level presentation of loan recommendations. Exhibit the highest ethical standards and confidentiality and maintain a high level of responsibility, initiative, and performance. 4256: Finalization of first 4255 project as needed. Continuation of credit analysis and research applied to companies in different three-digit industry code, advanced credit risk and financial modeling, loan portfolio management on legacy loans including takedown/paydown of revolving lines. Reporting for internal distribution and for sponsor.
Prerequisite(s): FIN 3254 and FIN 4254 or FIN 4244
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4256 - Credit Corps Lending Practicum (3 credits)
Credit underwriting of commercial loans in an experiential setting. Project work spans two semesters. 4255: First project and basic management of cash flows on legacy portfolio of loans. Credit analysis of middle market companies leading to recommendations for lending to such companies. Research on individual companies, their industries, or on commercial real estate projects. Research on relative loan pricing, trends in leverage loan markets. Professional-level presentation of loan recommendations. Exhibit the highest ethical standards and confidentiality and maintain a high level of responsibility, initiative, and performance. 4256: Finalization of first 4255 project as needed. Continuation of credit analysis and research applied to companies in different three-digit industry code, advanced credit risk and financial modeling, loan portfolio management on legacy loans including takedown/paydown of revolving lines. Reporting for internal distribution and for sponsor.
Prerequisite(s): FIN 4255
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4264 - Managing Risk with Derivatives (3 credits)
The types, payoff, and pricing of derivative securities and contracts and their application in managing financial risks faced by corporations. Topics include options, forwards, futures and swaps; managing foreign currency risk, interest rate risk, stock price risk, and commodity price risk; and risk management techniques. Must have a grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4274 - Equity Securities: Analysis and Management (3 credits)
Advanced valuation and analysis of equity securities with case applications. Critical analysis of advanced equity asset pricing models. Analysis of advanced equity portfolio management techniques, equity portfolio performance measurement, and equity portfolio performance attribution analysis. Identification and analysis of market anomalies and recent developments in equity analysis. Must have grade of C or better in prerequisites of FIN 3144 and 3154.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4275 - Analytics for Equity Securities and Portfolio Management (3 credits)
Selection and management of equity securities in an experimental setting. Analysis, selection, and investment in common stocks. Introduction to advanced analytical techniques in equity evaluation and portfolio analytics. Research individual companies, industries, economic sectors, and national and global macroeconomic trends. Use appropriate software to develop financial models. Present buy and sell recommendations for actual execution in the portfolio. Maintain a high level of fiduciary responsibility. Pass/Fail only. Membership in SEED (Student-Managed Endowment for Educational Development).
Prerequisite(s): FIN 3134
Corequisite(s): FIN 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4276 - Analytics for Equity Securities and Portfolio Management (3 credits)
Advanced management of equity portfolios in an experiential setting. Equity valuation and investing in equity securities. Advanced equity valuation analysis and modeling. Conduct and take a leadership role on teams that research individual companies, industries, and sectors. Research macroeconomic and international capital trends. Lead a team to present buy and sell recommendations for the portfolio and/or construct reports on equity topics. Present buy and sell recommendations for actual execution in the portfolio. Exhibit the highest ethical standards. Mentor new SEED analysts. Pass/Fail only. Membership in SEED (Student- Endowment for Educational Development).
Prerequisite(s): FIN 4274 and FIN 4275
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4284 - Free Markets, Individual freedom, and Economic Welfare (3 credits)
Course exposes students to various viewpoints on the role free markets can and do play in promoting individual freedom. Allocation of scarce resources, and in enhancing welfare. Explores the strengths and weaknesses of capitalism by critically evaluating the relationship between the economic efficiency achieved by capitalism and the attainment of welfare objectives. Other topics include current items such as globalization, price controls, income equality, outsourcing, corporate pricing power though monopoly/oligopoly, and government regulation of the economy.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4294 - Commodity Invt. Portfolios (3 credits)
Application of fundamental commodity analysis and valuation techniques utilized to create a commodity investment portfolio in an experiential setting. Analysis, selection, and advanced analytical techniques in domestic and international agricultural, energy and metal commodities applied to a simulated investment in a commodity portfolio. Maintain a high level of fiduciary responsibility through developing, maintaining, and interpreting portfolio performance on a daily basis.
Prerequisite(s): FIN 3134 and FIN 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

FIN 4314 - Field Projects in Finance (3 credits)
Finance-related business projects with external clients, which will include gathering and analyzing data, understanding relevant financial issues in a business context, formulating recommendations, and presenting analyses and recommendations in oral and written form. May be repeated once with different content for a maximum of 6 credit hours.
Prerequisite(s): FIN 3134 and FIN 3144 and FIN 3154
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

FIN 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4984 - Special Study (1-19 credits)
Special Study
Instructional Contact Hours: Variable credit course

FIN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FIN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Finance and Real Estate Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,9,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 4194	Analysis of Financial Statements [8,#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 3134	Financial Analytics [6,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [6,7,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [6,7,#]	3
FIN 4154	Real Estate Finance [3,#]	3
FIN 4214	Financial Modeling in Excel [11,#]	3
FIN 4254	Bank Management and Financial Services [11,#]	3
MGT 1104	Foundations of Business [2,3]	3
MGT 3404	Principles of Management [2,3,#]	3
PM 4684	Leasing Commercial Properties [#]	3
REAL 1014	Careers in Real Estate [#]	1
REAL/UAP 2004	Principles of Real Estate [#]	3
REAL 2044	Professional Development in Real Estate [2,3,#]	3
REAL 3024	Applied Real Estate Development [2,#]	3
REAL 3034	Real Estate Market Analysis [2,#]	3
REAL 4075	Commercial Real Estate Studio [2,10,#]	3
REAL 4076	Commercial Real Estate Studio [10,#]	3
REAL 4754	Real Estate Law [#]	3
Subtotal		61
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [4]	3
COMM 1016	Communication Skills (1F) [4]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with ENGL 3764 or ENGL 3774 or ENGL 2844		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2,3]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [5]	3
Subtotal		43
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics,

Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, REAL 2044 Professional Development in Real Estate, REAL 3024 Applied Real Estate Development, REAL 3034 Real Estate Market Analysis, BIT 3414 Operations and Supply Chain Management, MGT 4394 Strategic Management, REAL 4075 Commercial Real Estate Studio).

[3] FIN/REAL substitutions:

- MGT 1104 Foundations of Business substitutes for REAL 1004 Discovering Real Estate requirement.
- BIT 2405 Introduction to Business Statistics, Analytics, and Modeling substitutes for REAL 2034 Real Estate Data Analysis requirement.
- REAL 2044 Professional Development in Real Estate substitutes for ACIS 2504 Introduction to Accounting Analytics.
- MGT 3404 Principles of Management satisfies the "REAL choose one elective".
- FIN 4154 Real Estate Finance substitutes for REAL 3044 Financing Real Estate Projects requirement.

[4] ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

[5] Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

[6] Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

[7] Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics

[8] Students may substitute ACIS 3115 Intermediate Financial Accounting for ACIS 4194 Analysis of Financial Statements.

[9] FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

[10] REAL 4075 Commercial Real Estate Studio - REAL 4076 Commercial Real Estate Studio must be taken in sequence: Fall/Spring of the same academic year or Spring/Fall of the same calendar year.

[11] Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

[#] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation . Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Department Information

Students in Finance and Real Estate (FREL) are required to pursue Real Estate for Commercial Properties (RELC) as a second major. The second major will be automatically added for FREL Students and does not require additional courses not listed on this checksheet.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2,3]	3
COMM 1015	Communication Skills [4]	3
SOC 1004	Introductory Sociology [5]	3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2,3]	3
COMM 1016	Communication Skills [4]	3
REAL/UAP 2004	Principles of Real Estate [#]	3
REAL 1014	Careers in Real Estate [#]	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [6,#]	3
REAL 2044	Professional Development in Real Estate [2,3,#]	3
MGT 3404	Principles of Management [2,3,#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [6,7,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [6,7,#]	3
ACIS 4194	Analysis of Financial Statements [8,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,9,#]	3
REAL 3024	Applied Real Estate Development [2,#]	3
	Credits	**15**
Spring Semester		
FIN 4154	Real Estate Finance [3,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
MKTG 3104	Marketing Management [2,#]	3
REAL 3034	Real Estate Market Analysis [2,#]	3
	Credits	**15**
Fourth Year		
Fall Semester		
REAL 4075	Commercial Real Estate Studio [2,10,#]	3
REAL 4754	Real Estate Law [#]	3
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
FIN 4214	Financial Modeling in Excel [11,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Spring Semester		
REAL 4076	Commercial Real Estate Studio [10,#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
PM 4684	Leasing Commercial Properties [#]	3
FIN 4254	Bank Management and Financial Services [11,#]	3
MGT 4394	Strategic Management [2,#]	3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, REAL 2044 Professional Development in Real Estate, REAL 3024 Applied Real Estate Development, REAL 3034 Real Estate Market Analysis, BIT 3414 Operations and Supply Chain Management, MGT 4394 Strategic Management, REAL 4075 Commercial Real Estate Studio).

3 FIN/REAL substitutions:

- MGT 1104 Foundations of Business substitutes for REAL 1004 Discovering Real Estate requirement.

- BIT 2405 Introduction to Business Statistics, Analytics, and Modeling substitutes for REAL 2034 Real Estate Data Analysis requirement.
- REAL 2044 Professional Development in Real Estate substitutes for ACIS 2504 Introduction to Accounting Analytics.
- MGT 3404 Principles of Management satisfies the "REAL choose one elective".
- FIN 4154 Real Estate Finance substitutes for REAL 3044 Financing Real Estate Projects requirement.

4 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

5 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

6 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

7 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

8 Students may substitute ACIS 3115 Intermediate Financial Accounting for ACIS 4194 Analysis of Financial Statements.

9 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

10 REAL 4075 Commercial Real Estate Studio - REAL 4076 Commercial Real Estate Studio must be taken in sequence: Fall/Spring of the same academic year or Spring/Fall of the same calendar year.

11 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504, MATH 1524, ACIS 2115-2116, BIT 2405-2406, and ECON 2005-2006) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504, MATH 1524, ACIS 2115-2116, BIT 2405-
2406, ECON 2005-2006, MGT 1104, MGT or HTM 2314, MGT 3404, MKTG 3104, FIN 3104, FIN 3054 or FIN 3074, REAL 3024, REAL 3034, BIT 3414, MGT 4394, REAL 4075).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C- or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 REAL 4075 Commercial Real Estate Studio and REAL 4076 Commercial Real Estate Studio must be taken in sequence: Fall/Spring of the same academic year of Spring/Fall of the same calendar year.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

Finance Major with Corporate Financial Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 2164	Survey of Finance and Career Planning	1
FIN 3134	Financial Analytics [5,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
Subtotal		28

Option Required Courses		
ACIS 3115	Intermediate Financial Accounting [#]	3
or ACIS 4194	Analysis of Financial Statements	
FIN 4234	Venture Capital and Investment Banking [8,#]	3
FIN 4244	Asset Valuation and Corporate Governance [8,#]	3
FIN 4264	Managing Risk with Derivatives [8,#]	3
FCFM Electives [8,#]		
Select one of the following:		3
FIN 3114	Python/SQL for Data Analytics and Finance [#]	
FIN 4144	International Financial Management [#]	
FIN 4214	Financial Modeling in Excel [8,#]	
Subtotal		15
Free Electives [9,10]		
Select 18 credits of Free Electives		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by completing ENGL 3764 or ENGL 3774 or ENGL 2844 major requirement [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [4]	3
Subtotal		43
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

10 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding

Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
COMM 1015	Communication Skills [3]	3
FIN 2164	Survey of Finance and Career Planning	1
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**17**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
COMM 1016	Communication Skills [3]	3
SOC 1004	Introductory Sociology [4]	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [5,#]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Free Elective		3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
ACIS 3115 or ACIS 4194	Intermediate Financial Accounting [#] or Analysis of Financial Statements	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
FIN 4244	Asset Valuation and Corporate Governance [8,#]	3
FCFM Elective [8,#]		3
BIT 3414	Operations and Supply Chain Management [2,#]	3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
MKTG 3104	Marketing Management [2,#]	3
	Credits	**15**
Fourth Year		
Fall Semester		
FIN 4234	Venture Capital and Investment Banking [8,#]	3
FIN 4264	Managing Risk with Derivatives [8,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Elective [9]		3
Free Elective		3
	Credits	**15**
Spring Semester		
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 4394	Strategic Management [2,#]	3
Free Elective [10]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

FCFM Electives

Code	Title	Credits
Choose one - 3 credit hours		
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
FIN 4144	International Financial Management [#]	3
FIN 4214	Financial Modeling in Excel [8,#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

10 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

6 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. These courses are used to calculate the in-major GPA.

7 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

8 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

[9] Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

[10] COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills.

[11] Students are encouraged to take FIN 2114 Investments and Financial Literacy

Pathways General Education requirements https://www.pathways.prov.vt.edu/ (https://www.pathways.prov.vt.edu/)

Finance Major with Financial Accounting Option

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 2164	Survey of Finance and Career Planning	1
FIN 3134	Financial Analytics [5,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
Subtotal		28
Option Required Courses		
ACIS 3115	Intermediate Financial Accounting [#]	3
FIN 4214	Financial Modeling in Excel [8,#]	3
FIN 4244	Asset Valuation and Corporate Governance [8,9,#]	3
or FIN 4254	Bank Management and Financial Services	
or FIN 4274	Equity Securities: Analysis and Management	
ACIS Electives		
Select two of the following:		6
ACIS 3116	Intermediate Financial Accounting [#]	
ACIS 3314	Tax Impact on Decisions [#]	
ACIS 4214	Cost Planning and Control [#]	
FFAC Electives		
Select one of the following:		3
FIN 3114	Python/SQL for Data Analytics and Finance [#]	
FIN 4144	International Financial Management [#]	
FIN 4224	Fixed Income Securities: Analysis and Management [8,#]	
FIN 4234	Venture Capital and Investment Banking [8,#]	
FIN 4244	Asset Valuation and Corporate Governance [8,9,#]	
FIN 4254	Bank Management and Financial Services [8,9,#]	
FIN 4274	Equity Securities: Analysis and Management [8,9,#]	
Subtotal		18
Free Electives		
Select 15 credit hours of Free Electives [10,11]		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by completing ENGL 3764 or ENGL 3774 or ENGL 2844 major requirement [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [4]	3
Subtotal		43
Total Credits		**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics,

Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 Students cannot double count FIN 4244 Asset Valuation and Corporate Governance, FIN 4254 Bank Management and Financial Services, or FIN 4274 Equity Securities: Analysis and Management.

10 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

11 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

Course	Title	Credits
First Year		
Fall Semester		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
COMM 1015	Communication Skills [3]	3
SOC 1004	Introductory Sociology [4]	3
FIN 2164	Survey of Finance and Career Planning	1
	Credits	**17**

Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
COMM 1016	Communication Skills [3]	3
Select three credits from Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3104	Introduction to Finance [2,5]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [5,6]	3
ACIS 2504	Introduction to Accounting Analytics [5]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Free Elective		3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,7]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,7]	3
ACIS 3115	Intermediate Financial Accounting [5]	3
FIN 3054 or FIN 3074	Legal and Ethical Environment of Business [2,5] or Legal, Ethical, and Financing Issues for Entrepreneurs	3
MGT 3404	Principles of Management [2,5]	3
	Credits	**15**
Spring Semester		
ACIS elective [5]		3
ACIS Elective [5]		3
BIT 3414	Operations and Supply Chain Management [2,5]	3
ENGL 3764	Technical Writing [5]	3
MKTG 3104	Marketing Management [2,5]	3
	Credits	**15**
Fourth Year		
Fall Semester		
Select one of the following: [5,8]		3
FIN 4244	Asset Valuation and Corporate Governance	
FIN 4254	Bank Management and Financial Services	
FIN 4274	Equity Securities: Analysis and Management	
FIN Elective [5,8]		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Elective [9]		3
Free Elective		3
	Credits	**15**
Spring Semester		
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 4394	Strategic Management [2,5]	3
FIN Elective [5,8]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 **Policy 91:** Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 **Graduation requirement:** Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. These courses are used to calculate the inmajor GPA.

6 **Graduation requirement:** Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

7 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills.

10 Students are encouraged to take FIN 2114 Investments and Financial Literacy

Finance Major with Financial Risk Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 2164	Survey of Finance and Career Planning	1
FIN 3134	Financial Analytics [5,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
Subtotal		28
Option Required Courses		
ACIS 3115	Intermediate Financial Accounting [#]	3
or ACIS 4194	Analysis of Financial Statements	
FIN 3254	Credit Risk Analysis [#]	3
FIN 4224	Fixed Income Securities: Analysis and Management [8,#]	3
FIN 4254	Bank Management and Financial Services [8,#]	3
FNRM Electives [8,9,#]		
Select two of the following:		6
FIN 3114	Python/SQL for Data Analytics and Finance [#]	
FIN 4144	International Financial Management [#]	
FIN 4214	Financial Modeling in Excel [8,#]	
FIN 4234	Venture Capital and Investment Banking [8,#]	
FIN 4244	Asset Valuation and Corporate Governance [8,#]	
FIN 4264	Managing Risk with Derivatives [8,#]	
Subtotal		18
Free Electives [9,10,11]		
Select 15 credit hours of free electives		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) will be satisfied by completing major requirement ENGL 3764 or ENGL 3774 or ENGL 2844. [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [4]	3
Subtotal		43
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics,

Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 Seniors in the FNRM option are strongly encouraged to participate in the capstone experiential learning offered through FIN 4255 Credit Corps Lending Practicum - FIN 4256 Credit Corps Lending Practicum, Credit Corps/CREDIT, in the Fall and Spring semesters. Students must receive faculty approval to enroll in this professional lending experience to complete their major studies.

10 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

11 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
COMM 1015	Communication Skills [3]	3
FIN 2164	Survey of Finance and Career Planning	1
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**17**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
COMM 1016	Communication Skills [3]	3
SOC 1004	Introductory Sociology [4]	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3

ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [5,#]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
ACIS 3115 or ACIS 4194	Intermediate Financial Accounting [#] or Analysis of Financial Statements	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
FNRM Elective [8,9,#]		3
FIN 3254	Credit Risk Analysis [#]	3
FIN 4254	Bank Management and Financial Services [8,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
MKTG 3104	Marketing Management [2,#]	3
FIN 4224	Fixed Income Securities: Analysis and Management [8,#]	3
FNRM Elective [8,9,#]		3
Free Elective [9]		3
Free Elective [10]		3
	Credits	**15**
Spring Semester		
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Elective [9]		3
Free Elective [11]		3
	Credits	**15**
	Total Credits	**125**

FNRM Electives

Code	Title	Credits
Choose two - 6 credit hours		
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
FIN 4144	International Financial Management [#]	3
FIN 4214	Financial Modeling in Excel [8,#]	3
FIN 4234	Venture Capital and Investment Banking [8,#]	3
FIN 4244	Asset Valuation and Corporate Governance [8,#]	3
FIN 4264	Managing Risk with Derivatives [8,#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 Seniors in the FNRM option are strongly encouraged to participate in the capstone experiential learning offered through FIN 4255 Credit

Corps Lending Practicum - FIN 4256 Credit Corps Lending Practicum, Credit Corps/CREDIT, in the Fall and Spring semesters. Students must receive faculty approval to enroll in this professional lending experience to complete their major studies.

10 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

11 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Pre-requisites: Students are responsible for ensuring they have met necessary pre-requisites for all courses. Courses with pre-requisites are noted (e.g. BIT 2405 Introduction to Business Statistics, Analytics, and Modeling). Please refer to the Undergraduate Catalog or academic advisor.

6 Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted (e.g. FIN 3104 Introduction to Finance).

7 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy

8 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

9 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

10 Seniors in the FNRM option are strongly encouraged to participate in the capstone experiential learning offered through FIN 4255 Credit Corps Lending Practicum-FIN 4256 Credit Corps Lending Practicum in the Fall and Spring semesters. Students must meet the prerequisite courses (FIN 3254 Credit Risk Analysis and RMA certification, and (FIN 4244 Asset Valuation and Corporate Governance or FIN 4254 Bank Management and Financial Services)) and grade requirements (B- or higher) for the professional lending experience to complete their major studies.

11 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills.

12 Students are encouraged to take FIN 2114 Investments and Financial Literacy

13 Students cannot double count FIN 4244 Asset Valuation and Corporate Governance or FIN 4254 Bank Management and Financial Services.

Finance Major with Investment Management and Chartered Financial Analyst Option

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 2164	Survey of Finance and Career Planning	1
FIN 3134	Financial Analytics [5,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3

MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
Subtotal		28
Option Required Courses		
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
FIN 4214	Financial Modeling in Excel [8,#]	3
FIN 4224	Fixed Income Securities: Analysis and Management [8,#]	3
ACIS 3115	Intermediate Financial Accounting [#]	3
or ACIS 4194	Analysis of Financial Statements	
FIN 4274	Equity Securities: Analysis and Management [8,#]	3
Subtotal		15
Free Electives [9,10]		
Select 18 credit hours of free electives		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with ENGL 3764 or ENGL 3774 or ENGL 2844 [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [4]	3
Subtotal		61
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

10 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding

Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation . Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
COMM 1015	Communication Skills [3]	3
FIN 2164	Survey of Finance and Career Planning	1
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**17**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
COMM 1016	Communication Skills [3]	3
SOC 1004	Introductory Sociology [4]	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [5,#]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Free Elective		3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Spring Semester		
FIN 4224	Fixed Income Securities: Analysis and Management [8,#]	3
FIN 4214	Financial Modeling in Excel [8,#]	3
ACIS 3115 or ACIS 4194	Intermediate Financial Accounting [#] or Analysis of Financial Statements	3
MKTG 3104	Marketing Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Fourth Year		
Fall Semester		
FIN 4274	Equity Securities: Analysis and Management [8,#]	3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
Free Elective [9]		3
Free Elective		3
	Credits	**15**
Spring Semester		
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 4394	Strategic Management [2,#]	3
Free Elective [10]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of

Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

9 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills.

10 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Financial Planning and Wealth Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
ACIS 3115	Intermediate Financial Accounting [#]	3
or ACIS 4194	Analysis of Financial Statements	
ACIS 4344	Tax for Financial Planners [#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 2164	Survey of Finance and Career Planning	1
FIN 3124	Financial Planning for Professionals [#]	3
FIN 3134	Financial Analytics [5,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
FIN 3204	Risk and Insurance [#]	3
FIN 4004	Wills, Trusts, and Estates [#]	3
FIN 4124	Client Relationship Management [#]	3
FIN 4104	Retirement Planning [#]	3
FIN 4114	Financial Planning Technology and Modeling [#]	3
FIN 4134	Financial Planning Applications [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
Subtotal		55
Free Electives [8,9]		
Select remaining credits required for the degree		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by completing ENGL 3764 or ENGL 3774 or ENGL 2844 major requirement		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6

Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [4]	3
Subtotal		49
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

9 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation . Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Department Information

The Financial Planning and Wealth Management major is a registered program of the CFP® Board. Completion of the Financial Planning and Wealth Management major satisfies the education requirement to take the CFP® examination without any additional coursework. Virginia Tech does not certify individuals to use the CFP® and Certified Financial Planner™. CFP® certification is granted solely by the Certified Financial Planner Board of Standards, Inc. to individuals who, in addition to completing an educational requirement such as this CFP Board-

Registered Program, have met ethics, experience, and examination requirements. See http://www.CFPBoard.org (http://www.cfpboard.org/)

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
COMM 1015	Communication Skills [3]	3
SOC 1004	Introductory Sociology [4]	3
FIN 2164	Survey of Finance and Career Planning	1
	Credits	**17**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
COMM 1016	Communication Skills [3]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3104	Introduction to Finance [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
FIN 3134	Financial Analytics [5,#]	3
ACIS 2504	Introduction to Accounting Analytics [#]	3
FIN 3124	Financial Planning for Professionals [#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Seelect three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Third Year		
Fall Semester		
FIN 3144	Investments: Debt, Equity and Derivatives [5,6,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [5,6,#]	3
FIN 3204	Risk and Insurance [#]	3
FIN 3054	Legal and Ethical Environment of Business [2,7,#]	3
MKTG 3104	Marketing Management [2,#]	3
	Credits	**15**
Spring Semester		
ACIS 3115 or ACIS 4194	Intermediate Financial Accounting [#] or Analysis of Financial Statements	3
ACIS 4344	Tax for Financial Planners [#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 4124	Client Relationship Management [#]	3
MGT 3404	Principles of Management [2,#]	3
	Credits	**15**
Fourth Year		
Fall Semester		
FIN 4104	Retirement Planning [#]	3
FIN 4114	Financial Planning Technology and Modeling [#]	3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Spring Semester		
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
FIN 4134	Financial Planning Applications [#]	3
FIN 4004	Wills, Trusts, and Estates [#]	3
Free Elective [8]		3
Free Elective [9]		3
	Credits	**15**
	Total Credits	**125**

1. Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.
2. Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104

Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

6 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

7 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

8 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills.

9 Students are encouraged to take FIN 2114 Investments and Financial Literacy.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

5 Pre-requisites: Students are responsible for ensuring they have met necessary pre-requisites for all courses. Courses with pre-requisites are noted (e.g. BIT 2405 Introduction to Business Statistics, Analytics, and Modeling). Please refer to the Undergraduate Catalog or academic advisor.

6 Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted (e.g. FIN 3104 Introduction to Finance).

7 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy

8 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

9 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

10 COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills

11 Students are encouraged to take FIN 2114 Investments and Financial Literacy

FinTech and Big Data Analytics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,6,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 2314	Introduction to International Business [2]	3
or HTM 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 2115	Principles of Accounting [1,2]	3
ACIS 3115	Intermediate Financial Accounting [9,#]	3
or ACIS 4194	Analysis of Financial Statements	
BIT 3424	Introduction to Business Analytics Modeling [#]	3
CS 1064	Introduction to Programming in Python	3
CS 1114	Introduction to Software Design [#]	3

CS 2114	Software Design and Data Structures [#]	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization [13,#]	3
ENGL 3764	Technical Writing [#]	3
or ENGL 3774	Business Writing	
or ENGL 2844	Introduction to Professional and Technical Writing	
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
FIN 3134	Financial Analytics [7,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [7,8,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [7,8,#]	3
FIN 4214	Financial Modeling in Excel [10,#]	3
FIN 4314	Field Projects in Finance [10,11,#]	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus [1,2,12]	3
MGT 3304	Management Theory and Leadership Practice [2,#]	3
or MGT 3404	Principles of Management	
STAT 3005	Statistical Methods [1,2,12]	3
STAT 3006	Statistical Methods [1,2,12]	3
STAT 3104	Probability and Distributions [#]	3
FBDA Electives [10,12]		
Select one of the following:		3
FIN 4144	International Financial Management [#]	
FIN 4224	Fixed Income Securities: Analysis and Management [10,#]	
FIN 4264	Managing Risk with Derivatives [10,#]	
FIN 4274	Equity Securities: Analysis and Management [10,#]	
Subtotal		63
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F) [3]	3
COMM 1016	Communication Skills (1F) [3]	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with ENGL 3764 or ENGL 3774 or ENGL 2844 [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [1,2,4]	4
MATH 1226	Calculus of a Single Variable (5F) [1,2]	4
Three credit hours of Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) can be fulfilled with CS 1064		
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Three credit hours of Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) can be fulfilled with STAT 3005 [1,2,12]		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) fulfilled with CS 2114 [#]		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [5]	3
Subtotal		41
Total Credits		**125**

1. Policy 91: Pamplin students in a business degree program must complete ten business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204 Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.
2. Graduation requirement: Students must achieve a grade of C- or higher in select business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204 Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3304 Management Theory and Leadership Practice or MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).
3. ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.
4. Math readiness exam (ALEKS PPL), eligible AP credit, or MATH 1214 Preparation for Calculus pre-requisite course required for enrollment.
5. Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.
6. FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.
7. Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

[8] Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

[9] ACIS 2504 Introduction to Accounting Analytics pre-requisite is required for eligibility to enroll in ACIS 3115 Intermediate Financial Accounting.

[10] Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

[11] FIN 4314 Field Projects in Finance will provide an FBDA-specific capstone course for students of major. FBDA capstone coursework will be available only in Fall semesters. Courses listed in Spring of Year Three must be completed for students to be eligible to attempt FBDA FIN 4314 Field Projects in Finance coursework.

[12] Substitution of STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, MATH 2204 Introduction to Multivariable Calculus, and FDBA Elective (12 Credit hours) by CMDA 2005 Integrated Quantitative Sciences - CMDA 2006 Integrated Quantitative Sciences (also 12 credit hours) is acceptable provided CMDA is able to accommodate FBDA students. In that case, Policy 91 and Graduation Requirements (Footnotes 1, 2 above) will be modified accordingly.

[13] "Python" programming language is recommended.

[#] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Three Attempt Rule

In accordance with university policy, students are not allowed to take the same course more than three times. Please note that the Department of Finance will enforce this policy unless a special exception has been granted. If you are dropped from a course after you have taken it three times, please consult with your Pamplin academic advisor so that they can advise you of the next steps.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
CS 1064	Introduction to Programming in Python	3
ECON 2005	Principles of Economics [1,2]	3
COMM 1015	Communication Skills [3]	3
MATH 1225	Calculus of a Single Variable [1,2,4]	4
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
CS 1114	Introduction to Software Design [#]	3
STAT 3005	Statistical Methods [1,2,12]	3
MATH 1226	Calculus of a Single Variable [1,2]	4
COMM 1016	Communication Skills [3]	3
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
STAT 3006	Statistical Methods [1,2,12]	3
ECON 2006	Principles of Economics [1,2]	3
MATH 2114	Introduction to Linear Algebra	3
CS 2114	Software Design and Data Structures [#]	3
SOC 1004	Introductory Sociology [5]	3
	Credits	**18**
Spring Semester		
MATH 2204	Introduction to Multivariable Calculus [1,2,12]	3
FIN 3054	Legal and Ethical Environment of Business [2,6,#]	3
FIN 3104	Introduction to Finance [2,#]	3
FIN 3134	Financial Analytics [7,#]	3
STAT 3104	Probability and Distributions [#]	3
	Credits	**15**
Third Year		
Fall Semester		
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
FIN 3114	Python/SQL for Data Analytics and Finance [#]	3
MGT 2314 or HTM 2314	Introduction to International Business [2] or Introduction to International Business	3
MKTG 3104	Marketing Management [2,#]	3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**

Spring Semester		
BIT 3424	Introduction to Business Analytics Modeling [#]	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization [13,#]	3
FIN 3144	Investments: Debt, Equity and Derivatives [7,8,#]	3
FIN 3154	Corporate Financial Analytics and Strategy [7,8,#]	3
MGT 3304 or MGT 3404	Management Theory and Leadership Practice [2,#] or Principles of Management	3
	Credits	**15**
Fourth Year		
Fall Semester		
ACIS 3115 or ACIS 4194	Intermediate Financial Accounting [9,#] or Analysis of Financial Statements	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 4314	Field Projects in Finance [10,11,#]	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
FBDA Elective [10,12,#]		3
	Credits	**15**
Spring Semester		
FIN 4214	Financial Modeling in Excel [10,#]	3
MGT 4394	Strategic Management [2,#]	3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
ENGL 3764 or ENGL 3774 or ENGL 2844	Technical Writing [#] or Business Writing or Introduction to Professional and Technical Writing	3
	Credits	**15**
	Total Credits	**125**

FBDA Electives

Code	Title	Credits
Choose one - 3 credit hours		
FIN 4144	International Financial Management [#]	3
FIN 4224	Fixed Income Securities: Analysis and Management [10,#]	3
FIN 4264	Managing Risk with Derivatives [10,#]	3
FIN 4274	Equity Securities: Analysis and Management [10,#]	3

1 Policy 91: Pamplin students in a business degree program must complete ten business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204 Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204 Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3304 Management Theory and Leadership Practice or MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills - COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking.

4 Math readiness exam (ALEKS PPL), eligible AP credit, or MATH 1214 Preparation for Calculus pre-requisite course required for enrollment.

5 Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

6 FIN 3054 Legal and Ethical Environment of Business and FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs are equivalent courses. Students may take either course to satisfy graduation requirements.

7 Graduation requirement: Students must achieve a grade of C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

8 Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

9 ACIS 2504 Introduction to Accounting Analytics pre-requisite is required for eligibility to enroll in ACIS 3115 Intermediate Financial Accounting.

10 Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

11 FIN 4314 Field Projects in Finance will provide an FBDA-specific capstone course for students of major. FBDA capstone coursework will be available only in Fall semesters. Courses listed in Spring of Year Three must be completed for students to be eligible to attempt FBDA FIN 4314 Field Projects in Finance coursework.

12 Substitution of STAT 3005 Statistical Methods - STAT 3006 Statistical Methods, MATH 2204 Introduction to Multivariable Calculus, and FBDA Elective (12 Credit hours) by CMDA 2005 Integrated Quantitative Sciences - CMDA 2006 Integrated Quantitative Sciences (also 12 credit hours) is acceptable provided CMDA is able to accommodate FBDA students. In that case, Policy 91 and Graduation Requirements (Footnotes 1, 2 above) will be modified accordingly.

13 "Python" programming language is recommended.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 Policy 91: Pamplin students in a business degree program must complete ten business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204

Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, STAT 3005 Statistical Methods-STAT 3006 Statistical Methods, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement:Students must achieve a grade of C- or higher in select business courses (MATH 1225 Calculus of a Single Variable + MATH 1226 Calculus of a Single Variable + MATH 2204 Introduction to Multivariable Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, STAT 3005 Statistical Methods-STAT 3006 Statistical Methods, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 2314 Introduction to International Business or HTM 2314 Introduction to International Business, MGT 3304 Management Theory and Leadership Practice or MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business or FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing can substitute for COMM 1015 Communication Skills-COMM 1016 Communication Skills. However, students who make this substitution must also take COMM 2004 Public Speaking

[4] Students may use PSYC 1004 Introductory Psychology to satisfy the requirement if they meet the Pathway 7: Critical Analysis of Identity & Equity in the U.S. requirement with a different required course.

[5] Pre-requisites: Students are responsible for ensuring they have met necessary pre-requisites for all courses. Courses with pre-requisites are noted (e.g. BIT 2405 Introduction to Business Statistics, Analytics, and Modeling). Please refer to the Undergraduate Catalog or academic advisor

[6] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the inmajor GPA are noted (e.g. FIN 3104 Introduction to Finance).

[7] Graduation requirement: Students must achieve a grade or C or higher in FIN 3134 Financial Analytics, FIN 3144 Investments: Debt, Equity and Derivatives, and FIN 3154 Corporate Financial Analytics and Strategy.

[8] Students who receive a grade of C- in FIN 3134 Financial Analytics may enroll concurrently in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy while re-taking FIN 3134 Financial Analytics.

[9] Students who receive a grade of C- in FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy may enroll concurrently in FIN 42XX courses while re-taking FIN 3144 Investments: Debt, Equity and Derivatives and FIN 3154 Corporate Financial Analytics and Strategy. A grade of C or higher in FIN 3134 Financial Analytics is required before enrolling in FIN 42XX courses.

[10] COMM 2004 Public Speaking is required for students who did not take COMM 1015 Communication Skills and COMM 1016 Communication Skills.

Hospitality and Tourism Management

Our Website (http://www.htm.pamplin.vt.edu)

E-mail: htmdpt@vt.edu

Overview

The undergraduate program in hospitality and tourism management prepares students for leadership positions in hospitality and tourism, one of the world's largest industries. The department, which is ranked as one of the best in the world, seeks to provide students with a balance of industry-focused educational opportunities with directed work experiences. All students will take courses in hospitality, finance, food and beverage operations, tourism management, lodging operations, revenue management, and events. Special emphasis is placed on developing analytical, decision-making, leadership and communications skills. The degree requires an industry field study experience. The department offers two majors: Hospitality and Tourism Management (HTM) and Event and Experience Management (EEMG); four options: HTM Analytics (HTMA), HTM Services Management (HTMS), HTM Entrepreneurship & Innovation (ENIN), and HTM Sustainability, Ethics, & Advocacy (SEA); and one pathways minor: Event and Experience Management (EEMG).

The curriculum is flexible, allowing students to pursue specific areas of emphasis. Recommended areas include hospitality operations, global tourism experiences, restaurant and food management, meetings and events, and club and resort management. We also offer a dual degree program with Real Estate which prepares students for the field of asset management or hotel brokerage.

The department offers a variety of international programs and study abroad experiences to give students an enhanced understanding of cultural diversity, experience in international business methods, and practical understanding of hotel and restaurant management in other countries. Through industry scholarships and internal fundraising activities, students are able to attend state, regional, and national hospitality and tourism meetings.

The department is strongly committed to the placement of it undergraduate and graduate students. Industry partners participate in on-campus interview sessions. Industry representatives visit the department during fall and spring semesters to interview students for both permanent placement and internships. HTM conducts a career fair each spring semester for companies offering both career and internships opportunities. Major employers recruit HTM graduates at Virginia Tech, including Marriott, Hyatt, Walt Disney World, Hilton, Compass, Four Seasons, Ritz Carlton, B.F. Saul Hotel Division, Interstate Hotels, Crestline Hotels and Resorts, Cvent, Great American Restaurants, and Panera Bread Company. HTM consistently enjoys one of the top job placement rates on campus for its graduates.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Pathways to General Education (see "Academics (p. 9)") and toward the degree in Hospitality and Tourism Management.

Satisfactory progress requirements toward the B.S. in Business can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Event & Experience Management Major (https://catalog.vt.edu/undergraduate/pamplin-college-business/hospitality-tourism-management/event-experience-management/)
- Hospitality and Tourism Management Major (p. 710)
- Hospitality and Tourism Management Major with Analytics Option (p. 714)
- Hospitality and Tourism Management Major with Entrepreneurship and Innovation Option (p. 717)
- Hospitality and Tourism Management Major with Services Management Option (p. 720)
- Hospitality and Tourism Management Major with Sustainability, Ethics, & Advocacy Option (p. 723)

Head: Dr. Zheng "Phil" Xiang **Assistant Department Head**: Tom Duetsch **Director, MSBA-HTM Program**: Dr. Kristin Lamoureux **Undergraduate Program Coordinator:** Dr. Nancy McGehee **Graduate Program Coordinator:** Dr. Eojina Kim **Professors:** M. A. Khan, N.G. McGehee, J.L. Nicolau-Gonzalbez, M. Singal, and Z. Xiang. **Collegiate Associate Professor:** K. Lamoureux **Associate Professors:** E. Kim and F. Zach. **Assistant Professors**: S. Bernard Simpson **Professor of Practice:** T. Duetsch, S. Feigenbaum, C. Fitch, T. Warner, and D. Yanisko. **Visiting Professor:** M. Laughon **Adjunct Faculty:** E. Allen, S. Foster, P. Henderson, A. Hutchinson, M. Minarch, and L. Zwibak.

Undergraduate Course Descriptions (HTM)

HTM 1414 - Introduction to Hospitality and Tourism Management (3 credits)
Hospitality & Tourism industry segmentation, management structures and practices, the significance of service delivery, economic impact of tourism and career opportunities. Concepts examined through readings, case studies and industry gues speakers.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 2104 - Careers in Hospitality and Tourism (1 credit)
Provide students with an early start on understanding and identifying the many career options in the field of Hospitality and Tourism Management. In-depth focus on the different skills and training necessary for various career paths, including core hospitality and tourism management, hospitality and tourism business acumen, and hospitality and tourism strategy and innovation. Emphasize the importance of personal job search strategies and provide networking opportunities with leaders in the industry. Students will create professional materials, including resumes and online profiles. Serves as a foundational course in preparing students for career success in the Hospitality and Tourism Management field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

HTM 2314 - Introduction to International Business (3 credits)
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 2314

HTM 2434 - Hospitality Sales (3 credits)
A comprehensive study of the management of the sales function and its role in the overall financial performance of hospitality operations.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2454 - Global Travel & Tourism Management (3 credits)
Introduction to travel and tourism both domestically and abroad. Includes topics such as the history, sociology and psychology of tourism; the tourism system, including private industry, associations and governing bodies; measuring and predicting travel motivations, behavior, and demand; and management issues in a global context. Course concludes with an international travel research final project.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2464 - Designing the Service Experience (3 credits)
An overview of the service industry, its historical and economic importance, social, psychological and cultural impacts and future trends. Emphasizes the unique characteristics and management challenges of service organizations.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2474 - Introduction to Meetings and Convention Management (3 credits)
A study of the meetings and convention industry. Focus on the components and processes involved in developing and conducting meetings and conventions.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2514 - Catering Management (3 credits)
Introduces students to various venues in which catering services can be offered, and presents an overview of the functions, processes, and controls found in successful catering management and operations; emphasis is placed on the sales/marketing aspects of the business.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2954 - Hospitality and Tourism Study Abroad (3 credits)
This course provides students with an international hospitality and tourism management business experience. It is only offered as part of a program outside the United States. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. This course can be taken twice for a maximum of six credit hours. Sophomore standing and a minimum GPA of 3.0 required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HTM 2964 - Field Study (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 3044 - Private Club Management (3 credits)
Develop an understanding of the private club sector of the hospitality industry. Topic areas are divided into club fundamentals, revenue-generating operations within clubs and support functions/departments of club operations. Junior standing as well as background courses in basic financial management are suggested.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3244 - Franchising and Ownership in the Services Industries (3 credits)
Theory and practice of franchising as a form of business ownership and a vehicle for entrepreneurship. Contemporary issues related to franchising in different segments of the services industries including hospitality and tourism. Legal aspects, financial viability, ethical issues, and agency relationships in franchising. Franchise concept development, franchisor-franchisee relationship, franchise agreements, family business, minority franchising, and international franchising. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3414 - Chef Lab: Culinary Operations Management (4 credits)
Food and kitchen safety, hazard analysis, purchasing, recipe development, costing, and volume food preparation, in a commercial kitchen lab experience one day per week along with a two hour per week lecture. Design/Lab Studio. Pre: Sophomore standing.
Instructional Contact Hours: (2 Lec, 2 Lab, 4 Crd)

HTM 3424 - Event Management (3 credits)
Management of special events in the hospitality and tourism industry. Organizational functions necessary for designing a broad range of special events, using formal elements of design to deliver successful events through use of effectively designed floor plans, event flow and logistics, risk management and contingency planning as well as analyzing the factors that influence an events success. Examine ethical issues at play in the context of modern event planning and implementation. Study review processes, evaluation methods and techniques used in events management. Sophomore standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3444 - Hospitality Financial Management (3 credits)
The application of accounting, finance, and cost control principles to hospitality industry organizations. The focus of this course is to provide future food service and lodging organization managers with the ability to handle the unique problems regarding financial analysis and cost control in this industry.
Prerequisite(s): ACIS 2116 and ECON 2006
Corequisite(s): FIN 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3484 - Socio-Cultural Impacts of Tourism (3 credits)
A study of both historic and current impacts of tourism on family, community, culture, government, globalization, and the environment at the domestic and international levels. The course uses a sustainable tourism framework to examine the complex ways in which tourism both affects and is affected by modern society worldwide. Includes topics such as eco-tourism, volunteer tourism and space tourism.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3524 - Lodging Management (3 credits)
Organization, function, and management of lodging operations. Current issues and management challenges in the lodging industry. Applications of revenue management to lodging systems. Pre: Sophomore standing
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

HTM 3954 - HTM Study Abroad (1-6 credits)
This course provides students with an international hospitality and tourism management business experience. Students will be required to apply their knowledge and skills from their Pamplin College of Business core courses within this course. Students will learn from the structured educational experience developed by the faculty directing the study abroad program. Pamplin College of Business majors must have been approved for upper division course- work.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

HTM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4334 - Sustainable Entrepreneurship and Innovation in Hospitality & Tourism (3 credits)
Analysis of hospitality and tourism innovative and entrepreneurial enterprises to pursue sustainable growth. Analyze the sustainability of hospitality & tourism business ideas regarding growth opportunities considering societal, demographic, and environmental changes from a variety of sources. An examination of the key elements of sustainable entrepreneurship for hospitality and tourism enterprises that apply across a range of business models. Includes a field based, experiential learning project where teams collaborate to analyze data from multiple sources to develop and execute business ideas for existing or new enterprises. Pre: Junior standing.
Prerequisite(s): MGT 2064 or AAEC 2434
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4354 - Information Technology and Social Media in Hospitality and Tourism (3 credits)
Introduction to the strategic use of information technology (IT) in todays hospitality and tourism organizations. Includes the most current and widely used information systems in operation, management, and e-business in hospitality and tourism as well as identification, discussion and debate of the ethical issues associated with these systems. Study of social media as a marketing tool for hospitality and tourism businesses. Examine impacts of IT on organizations and the industry as a whole. Pre: Sophomore standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4414 - Restaurant Management: Design and Innovation (3 credits)
Reviews organizational structures, terminology, and categories associated with restaurant management. Discusses principles of restaurant management, including concept design development, financial analysis, daily operations, and customer service. Focuses on emerging trends in technology and innovation. Case study discussions of current issues and challenges in the industry, development of comprehensive restaurant business plan, and "Training for Intervention Procedures" (TIPS) certification.
Prerequisite(s): HTM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4434 - Event and Experience Management Senior Workshop (3 credits)
Senior experiential learning workshop to integrate and apply ethics, research, and design concepts from past coursework by engaging in actual professional events and experiences. Explore and understand the complexity of planning, coordination, and evaluation of events and the impact on the human experience. Capstone for Pathways Minor in Event & Experience Management. Pre: Senior Standing; Registered for the Event and Experience Management Pathways Minor.
Prerequisite(s): HTM 3424
Pathway Concept Area(s): 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4444 - Winery Tourism (3 credits)
The course focuses on the role of wine and wineries in tourism, wine marketing and management in the hospitality industry, and examines the components of a winery. Students must be 21 years of age due to the inclusion of wine tasting in the course. COURSE FEE: $18.
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4454 - Hospitality Revenue Management (3 credits)
Examines lodging and foodservices Revenue Management (RM) issues. Customer-centric approach, explores RM from various traditional academic perspectives, including economics, pricing, forecasting, consumer behavior, accounting, finance, and human resources. Management-oriented, emphasizes practical aspects of decision-making. Applies theoretical concepts through class discussion, group projects and individual assignments.
Prerequisite(s): HTM 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4464 - Human Resources Management in the Hospitality Industry (3 credits)
An overview of the concepts of human resources management as applied to the specific environments within the hospitality industry.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4474 - Hospitality & Tourism Law (3 credits)
Managerial approach to the law that applies to hotels, food-service establishments, events, and tourism; special focus on manager's duties to guests. Key concepts covered include contract and property law, licensing and permits, labor relations, risk management including food and beverage issues, safety and security, and liability and negligence.
Prerequisite(s): FIN 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4484 - International Tourism (3 credits)
Survey of global travel and tourism issues, including trends and patterns of global tourism, flow models, constraints and obstacles to international travel, demand for travel and tourism, tourism supply distribution, destination competitiveness, tourist safety and security, international travel and tourism organizations, performance measures. Analysis of sustainable indicators in protected areas and world heritage sites, tourism statistics and trends.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4514 - Hospitality Market Data Analysis (3 credits)
Extraction and analysis of industry data on a selected market for development and presentation of the Market Study in a worldwide competition among other universities. In conjunction with a leading hospitality industry data provider, students have an opportunity to extract and analyze current industry data. Expands teamwork and communication skills through written and oral delivery of the study. Impact Analysis study of a recent current event on hotels, related and non-related travel sectors.
Prerequisite(s): HTM 3524 and HTM 3444 and HTM 4454
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4964 - Field Study in HTM (3 credits)
Prerequisite(s): (HTM 3414 and HTM 3524) or (HTM 3414 and HTM 3444) or (HTM 3254 and HTM 3444)
Instructional Contact Hours: (3 Lec, 3 Crd)

HTM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HTM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Hospitality and Tourism Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3

Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3444	Hospitality Financial Management [#]	3
HTM 3524	Lodging Management [#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
HTM 4454	Hospitality Revenue Management [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4964	Field Study in HTM [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
HTM Electives [#]		
12 credit hours needed; 6 credit hours must be at the 3000 or 4000 level [5,6]		12
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	
HTM 2434	Hospitality Sales [#]	
HTM 2454	Global Travel & Tourism Management [#]	
HTM 2464	Designing the Service Experience [#]	
HTM 2474	Introduction to Meetings and Convention Management [#]	
HTM 2514	Catering Management [#]	
HTM 2954	Hospitality and Tourism Study Abroad [#]	
HTM 3044	Private Club Management [#]	
HTM 3244	Franchising and Ownership in the Services Industries [#]	
HTM 3424	Event Management [#]	
HTM 3484	Socio-Cultural Impacts of Tourism [#]	
HTM 3954	HTM Study Abroad [#]	
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	
HTM 4434	Event and Experience Management Senior Workshop [#]	
HTM 4444	Winery Tourism [#]	
HTM 4474	Hospitality & Tourism Law [#]	
HTM 4484	International Tourism [#]	
HTM 4514	Hospitality Market Data Analysis [#]	
Subtotal		52
Free Electives		
Select six hours of free elective credits		6
Subtotal		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) [7]		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) [4]		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [8]		3
Subtotal		46
Total Credits		**125**

Areas of Emphasis

Students may choose to concentrate HTM electives in specific areas of emphasis based on career interests.

Hospitality Operations Management

Code	Title	Credits
HTM 2434	Hospitality Sales [#]	3
HTM 2464	Designing the Service Experience [#]	3
HTM 2474	Introduction to Meetings and Convention Management [#]	3
HTM 3044	Private Club Management [#]	3
HTM 3244	Franchising and Ownership in the Services Industries [#]	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3

Restaurant & Food Management

Code	Title	Credits
HTM 2464	Designing the Service Experience [#]	3
HTM 2514	Catering Management [#]	3
HTM 3244	Franchising and Ownership in the Services Industries [#]	3
HTM 3424	Event Management [#]	3

HTM 4354	Information Technology and Social Media in Hospitality and Tourism #	3
HTM 4444	Winery Tourism #	3

International Tourism Management

Code	Title	Credits
HTM 2454	Global Travel & Tourism Management #	3
HTM 2954 or HTM 3954	Hospitality and Tourism Study Abroad # HTM Study Abroad	3
HTM 3484	Socio-Cultural Impacts of Tourism #	3
HTM 4444	Winery Tourism #	3
HTM 4484	International Tourism #	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 HTM 3484 Socio-Cultural Impacts of Tourism recommended (Event & Experience Management Pathways minor course)

4 HTM 3424 Event Management recommended (Event & Experience Management Pathways minor course)

5 HTM 4354 Information Technology and Social Media in Hospitality and Tourism recommended (Event & Experience Management Pathways minor course)

6 Students must take at least 6 credit hours of HTM electives at the 3000 or 4000 level.

7 ITDS 1114 Design Appreciation recommended (Event & Experience Management Pathways minor course)

8 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as a pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Department Information:

Students in the HTM major may choose to pursue the Event & Experience Management Pathways minor.

Students in the HTM major cannot double major with the Event & Experience Management Major.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
	Credits	**16**

Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
	Credits	**18**
Spring Semester		
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3524	Lodging Management [#]	3
Select three credit hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) [4]		3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Free Elective		3
	Credits	**16**
Third Year		
Fall Semester		
HTM 3444	Hospitality Financial Management [#]	3
MKTG 3104	Marketing Management [2,#]	3
HTM Elective [#]		3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
HTM 4454	Hospitality Revenue Management [#]	3
HTM Elective [#]		3
MGT 3404	Principles of Management [2,#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
Select three credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
HTM 4964	Field Study in HTM [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM Elective [5,6,#]		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) [7]		3
	Credits	**15**
Spring Semester		
HTM Elective [6,#]		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MGT 4394	Strategic Management [2,#]	3
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [8]		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

HTM Electives

Code	Title	Credits
12 credit hours needed; 6 credit hours must be at the 3000 or 4000 level		
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	1
HTM 2434	Hospitality Sales [#]	3
HTM 2454	Global Travel & Tourism Management [#]	3
HTM 2464	Designing the Service Experience [#]	3
HTM 2474	Introduction to Meetings and Convention Management [#]	3
HTM 2514	Catering Management [#]	3
HTM 2954	Hospitality and Tourism Study Abroad [#]	3
HTM 3044	Private Club Management [#]	3
HTM 3244	Franchising and Ownership in the Services Industries [#]	3
HTM 3424	Event Management [#]	3
HTM 3484	Socio-Cultural Impacts of Tourism [#]	3
HTM 3954	HTM Study Abroad [#]	3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
HTM 4434	Event and Experience Management Senior Workshop [#]	3
HTM 4444	Winery Tourism [#]	3
HTM 4474	Hospitality & Tourism Law [#]	3
HTM 4484	International Tourism [#]	3
HTM 4514	Hospitality Market Data Analysis [#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business,

HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 HTM 3484 Socio-Cultural Impacts of Tourism recommended (Event & Experience Management Pathways minor course)

4 HTM 3424 Event Management recommended (Event & Experience Management Pathways minor course)

5 HTM 4354 Information Technology and Social Media in Hospitality and Tourism recommended (Event & Experience Management Pathways minor course)

6 Students must take at least 6 credit hours of HTM electives at the 3000 or 4000 level.

7 ITDS 1114 Design Appreciation recommended (Event & Experience Management Pathways minor course)

8 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as a pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Hospitality and Tourism Management Major with Analytics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3444	Hospitality Financial Management [#]	3
HTM 3524	Lodging Management [#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
HTM 4454	Hospitality Revenue Management [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4964	Field Study in HTM [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		40
Option Required Courses		
BIT 4604	Data Governance, Privacy and Ethics [#]	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
HTM 4514	Hospitality Market Data Analysis [7,#]	3
HTM Analytics Electives		
Select two of the following:		6
BIT/CS/PSCI 2164	Foundations of Contemporary Security Environments [#]	
BIT 3424	Introduction to Business Analytics Modeling [#]	
CS 1064	Introduction to Programming in Python [#]	
HTM 2464	Designing the Service Experience [#]	
HTM Electives (3 credit hours needed)		*3*
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	
HTM 2434	Hospitality Sales [#]	
HTM 2454	Global Travel & Tourism Management [#]	
HTM 2474	Introduction to Meetings and Convention Management [#]	
HTM 2514	Catering Management [#]	
HTM 2954	Hospitality and Tourism Study Abroad [#]	
HTM 3044	Private Club Management [#]	
HTM 3244	Franchising and Ownership in the Services Industries [#]	
HTM 3424	Event Management [#]	
HTM 3484	Socio-Cultural Impacts of Tourism [#]	
HTM 3954	HTM Study Abroad [#]	
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	
HTM 4434	Event and Experience Management Senior Workshop [#]	
HTM 4444	Winery Tourism [#]	
HTM 4474	Hospitality & Tourism Law [#]	
HTM 4484	International Tourism [#]	
Subtotal		18
Free Electives		
Select three hours of Free Electives		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		

Select three hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		3
3 credit hours fulfilled by completion of required course BIT 4604 #		
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) [5]		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) [4]		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [6]		3
Subtotal		43
Total Credits		**125**

1. Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.
2. Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).
3. HTM 3484 Socio-Cultural Impacts of Tourism recommended (Event & Experience Management Pathways minor course)
4. HTM 3424 Event Management recommended (Event & Experience Management Pathways minor course)
5. ITDS 1114 Design Appreciation recommended (Event & Experience Management Pathways minor course)
6. Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).
7. HTM 4514 Hospitality Market Data Analysis is only offered in the Fall Semester.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3

MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
	Credits	**18**
Spring Semester		
HTM 3414	Chef Lab: Culinary Operations Management #	4
HTM 3524	Lodging Management #	3
Select three credit hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) [4]		3
HTM Analytics Elective #		3
Free Elective		3
	Credits	**16**
Third Year		
Fall Semester		
HTM 3444	Hospitality Financial Management #	3
MKTG 3104	Marketing Management [2,#]	3
HTM Analytics Elective #		3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
HTM 4454	Hospitality Revenue Management #	3
HTM Elective #		3
MGT 3404	Principles of Management [2,#]	3
HTM 4414	Restaurant Management: Design and Innovation #	3
Select three credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
HTM 4964	Field Study in HTM #	3
BIT 4604	Data Governance, Privacy and Ethics #	3
HTM 4514	Hospitality Market Data Analysis [7,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) [5]		3
	Credits	**15**
Spring Semester		
HTM 4354	Information Technology and Social Media in Hospitality and Tourism #	3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MGT 4394	Strategic Management [2,#]	3
HTM 4464	Human Resources Management in the Hospitality Industry #	3
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or free elective [6]		3
	Credits	**15**
	Total Credits	**125**

HTM Analytics Electives

Code	Title	Credits
Choose two - 6 credit hours		
BIT 3424	Introduction to Business Analytics Modeling #	3
BIT/CS/PSCI 2164	Foundations of Contemporary Security Environments #	3
CS 1064	Introduction to Programming in Python #	3
HTM 2464	Designing the Service Experience #	3

HTM Electives

Code	Title	Credits
3 credit hours needed		
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) #	1
HTM 2434	Hospitality Sales #	3
HTM 2454	Global Travel & Tourism Management #	3
HTM 2474	Introduction to Meetings and Convention Management #	3
HTM 2514	Catering Management #	3
HTM 2954	Hospitality and Tourism Study Abroad #	3
HTM 3044	Private Club Management #	3
HTM 3244	Franchising and Ownership in the Services Industries #	3
HTM 3424	Event Management #	3
HTM 3484	Socio-Cultural Impacts of Tourism #	3
HTM 3954	HTM Study Abroad #	3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism #	3
HTM 4434	Event and Experience Management Senior Workshop #	3
HTM 4444	Winery Tourism #	3
HTM 4474	Hospitality & Tourism Law #	3
HTM 4484	International Tourism #	3

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must

complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 HTM 3484 Socio-Cultural Impacts of Tourism recommended (Event & Experience Management Pathways minor course)

4 HTM 3424 Event Management recommended (Event & Experience Management Pathways minor course)

5 ITDS 1114 Design Appreciation recommended (Event & Experience Management Pathways minor course)

6 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).

7 HTM 4514 Hospitality Market Data Analysis is only offered in the Fall Semester.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Hospitality and Tourism Management Major with Entrepreneurship and Innovation Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,4,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3444	Hospitality Financial Management [#]	3
HTM 3524	Lodging Management [#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
HTM 4454	Hospitality Revenue Management [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4964	Field Study in HTM [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		40
Option Required Courses		
ENGE 2094	Create!: Ideation & Innovation [#]	3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
STS 2254	Innovation in Context [#]	3
or ENGL 1654	Introduction to Science Fiction and Fantasy	
HTM ENIN Sales & Service Electives		
Select two of the following:		6
HTM 2434	Hospitality Sales [#]	
HTM 2464	Designing the Service Experience [#]	
HTM 2474	Introduction to Meetings and Convention Management [#]	
HTM 3244	Franchising and Ownership in the Services Industries [6,#]	
HTM ENIN Entrepreneurship Electives		
Select one of the following:		3
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	
MGT 3074	Social Entrepreneurship [#]	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	
MGT 3094	Global Entrepreneurship [#]	
MGT 4064	Developing Entrepreneurial Ventures [#]	
HTM Electives (3 credit hours needed)		
Select one of the following:		3
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	
HTM 2454	Global Travel & Tourism Management [#]	
HTM 2514	Catering Management [#]	
HTM 2954	Hospitality and Tourism Study Abroad [#]	
HTM 3044	Private Club Management [#]	
HTM 3424	Event Management [#]	
HTM 3484	Socio-Cultural Impacts of Tourism [#]	
HTM 3954	HTM Study Abroad [#]	
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	
HTM 4434	Event and Experience Management Senior Workshop [#]	
HTM 4444	Winery Tourism [#]	

HTM 4474	Hospitality & Tourism Law [#]	
HTM 4484	International Tourism [#]	
HTM 4514	Hospitality Market Data Analysis [#]	
Subtotal		24
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
3 credit hours fulfilled by completion of STS 2254 or ENGL 1654 [#]		
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) fulfilled by completion of MGT 2064 [#]		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [5]		3
Subtotal		40
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 CSES 2244 Agriculture, Global Food Security and Health (fall only) or SPES 2004 Cannabis - Science, Industry, and Culture (spring only) strongly recommended.

4 FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs is strongly recommended instead of FIN 3054 Legal and Ethical Environment of Business

5 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as a pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).

6 HTM 3244 Franchising and Ownership in the Services Industries is typically offered in spring semesters only.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
STS 2254 or ENGL 1654	Innovation in Context [#] or Introduction to Science Fiction and Fantasy	3
ENGE 2094	Create!: Ideation & Innovation [#]	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
	Credits	**18**
Spring Semester		
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3524	Lodging Management [#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		3
	Credits	**16**
Third Year		
Fall Semester		
HTM 3444	Hospitality Financial Management [#]	3
MKTG 3104	Marketing Management [2,#]	3
HTM ENIN Sales & Service Elective [#]		3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
HTM 4454	Hospitality Revenue Management [#]	3
HTM ENIN Sales & Service Elective [#]		3
MGT 3404	Principles of Management [2,#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
Select three credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
HTM 4964	Field Study in HTM [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	3
FIN 3054	Legal and Ethical Environment of Business [2,4,#]	3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**
Spring Semester		
HTM Elective [#]		3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		3
MGT 4394	Strategic Management [2,#]	3
HTM ENIN Entrepreneurship Elective [#]		3
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [5]		3
	Credits	**15**
	Total Credits	**125**

HTM ENIN Sales & Service Electives

Code	Title	Credits
Choose two - 6 credit hours		
HTM 2434	Hospitality Sales [#]	3
HTM 2464	Designing the Service Experience [#]	3
HTM 2474	Introduction to Meetings and Convention Management [#]	3
HTM 3244	Franchising and Ownership in the Services Industries [6, #]	3

HTM ENIN Entrepreneurship Electives

Code	Title	Credits
Choose one - 3 credit hours		
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	3
MGT 3074	Social Entrepreneurship [#]	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	3
MGT 3094	Global Entrepreneurship [#]	3
MGT 4064	Developing Entrepreneurial Ventures [#]	3

HTM Electives

Code	Title	Credits
3 credit hours needed		
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	1
HTM 2454	Global Travel & Tourism Management [#]	3

HTM 2514	Catering Management [#]	3
HTM 2954	Hospitality and Tourism Study Abroad [#]	3
HTM 3044	Private Club Management [#]	3
HTM 3424	Event Management [#]	3
HTM 3484	Socio-Cultural Impacts of Tourism [#]	3
HTM 3954	HTM Study Abroad [#]	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
HTM 4434	Event and Experience Management Senior Workshop [#]	3
HTM 4444	Winery Tourism [#]	3
HTM 4474	Hospitality & Tourism Law [#]	3
HTM 4484	International Tourism [#]	3
HTM 4514	Hospitality Market Data Analysis [#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 CSES 2244 Agriculture, Global Food Security and Health (fall only) or SPES 2004 Cannabis - Science, Industry, and Culture (spring only) strongly recommended.

4 FIN 3074 Legal, Ethical, and Financing Issues for Entrepreneurs is strongly recommended instead of FIN 3054 Legal and Ethical Environment of Business.

5 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as a pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement. HTM 4434 Event and Experience Management Senior Workshop recommended (Event & Experience Management Pathways minor course).

6 HTM 3244 Franchising and Ownership in the Services Industries is typically offered in spring semesters only.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Hospitality and Tourism Management Major with Services Management Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3444	Hospitality Financial Management [#]	3
HTM 3524	Lodging Management [#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
HTM 4454	Hospitality Revenue Management [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4964	Field Study in HTM [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
Subtotal		40
Option Required Courses		
HTM 2464	Designing the Service Experience [#]	3
HTM 3044	Private Club Management [4,5,#]	3
or HTM 3244	Franchising and Ownership in the Services Industries	
HTM 3424	Event Management [#]	3
HTM 4474	Hospitality & Tourism Law [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	3
MKTG 4204	Consumer Behavior [#]	3
PSYC 2084	Social Psychology [#]	3
HTM Electives (3 credit hours needed)		*3*
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	
HTM 2434	Hospitality Sales [#]	

HTM 2454	Global Travel & Tourism Management #	
HTM 2474	Introduction to Meetings and Convention Management #	
HTM 2514	Catering Management #	
HTM 2954	Hospitality and Tourism Study Abroad #	
HTM 3484	Socio-Cultural Impacts of Tourism #	
HTM 3954	HTM Study Abroad #	
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism #	
HTM 4354	Information Technology and Social Media in Hospitality and Tourism #	
HTM 4434	Event and Experience Management Senior Workshop #	
HTM 4444	Winery Tourism #	
HTM 4484	International Tourism #	
HTM 4514	Hospitality Market Data Analysis #	
Subtotal		24
Free Electives		
Select three credit hours in Free Electives		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled by completion of MGT 4334		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) fulfilled by completion of HTM 3424		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completion of MGT 4334		
Subtotal		37
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 HTM 3484 Socio-Cultural Impacts of Tourism is recommended (Event & Experience Management Pathways minor course)

4 HTM 3044 Private Club Management is typically offered in spring semesters only.

5 HTM 3244 Franchising and Ownership in the Services Industries is typically offered in spring semesters only.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [3]		3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
PSYC 1004	Introductory Psychology	3
	Credits	**18**
Spring Semester		
HTM 3414	Chef Lab: Culinary Operations Management #	4
HTM 3524	Lodging Management #	3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
HTM 2464	Designing the Service Experience #	3
Select three credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Third Year		
Fall Semester		
HTM 3444	Hospitality Financial Management #	3
MKTG 3104	Marketing Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Free Elective		3
	Credits	**15**
Spring Semester		
HTM 4454	Hospitality Revenue Management #	3
HTM 3044 or HTM 3244	Private Club Management [4,5,#] or Franchising and Ownership in the Services Industries	3
MGT 3404	Principles of Management [2,#]	3
HTM 4414	Restaurant Management: Design and Innovation #	3
PSYC 2084	Social Psychology #	3
	Credits	**15**
Fourth Year		
Fall Semester		
HTM 4964	Field Study in HTM #	3
HTM 4464	Human Resources Management in the Hospitality Industry #	3
HTM 3424	Event Management #	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Spring Semester		
HTM 4474	Hospitality & Tourism Law #	3
HTM Elective #		3
MGT 4394	Strategic Management [2,#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility #	3
MKTG 4204	Consumer Behavior #	3
	Credits	**15**
	Total Credits	**125**

HTM Electives

Code	Title	Credits
3 credit hours needed		
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) #	1
HTM 2434	Hospitality Sales #	3
HTM 2454	Global Travel & Tourism Management #	3
HTM 2474	Introduction to Meetings and Convention Management #	3
HTM 2514	Catering Management #	3
HTM 2954	Hospitality and Tourism Study Abroad #	3
HTM 3484	Socio-Cultural Impacts of Tourism #	3
HTM 3954	HTM Study Abroad #	3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism #	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism #	3
HTM 4434	Event and Experience Management Senior Workshop #	3
HTM 4444	Winery Tourism #	3
HTM 4484	International Tourism #	3
HTM 4514	Hospitality Market Data Analysis #	3

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] HTM 3484 Socio-Cultural Impacts of Tourism is recommended (Event & Experience Management Pathways minor course)

[4] HTM 3044 Private Club Management is typically offered in spring semesters only.

[5] HTM 3244 Franchising and Ownership in the Services Industries is typically offered in spring semesters only.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Hospitality and Tourism Management Major with Sustainability, Ethics, & Advocacy Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3444	Hospitality Financial Management [#]	3
HTM 3524	Lodging Management [#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
HTM 4454	Hospitality Revenue Management [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM 4964	Field Study in HTM [#]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		40
Option Required Courses		
HTM 2454	Global Travel & Tourism Management [3,#]	3
or GEOG 1115	Seeking Sustainability	
or NR 1115	Seeking Sustainability	
HTM 3484	Socio-Cultural Impacts of Tourism [#]	3
HTM 4484	International Tourism [#]	3
or PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
ENGL 2844	Introduction to Professional and Technical Writing [#]	3
FREC 2124	Forests, Society & Climate [4,#]	3
or GEOS 1024	Earth Resources, Society, and Environment	
FREC/NR/LAR 2554	Leadership for Global Sustainability [#]	3
or BIT 4604	Data Governance, Privacy and Ethics	
HTM SEA Electives		
Select one of the following:		3
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	
SOC 2024	Sociology of Race and Ethnicity [#]	
SOC 2034	Diversity and Community Engagement [#]	
HTM Electives - 6 credit hours needed [5,7]		*6*
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	
HTM 2434	Hospitality Sales [#]	
HTM 2454	Global Travel & Tourism Management [7,#]	
HTM 2464	Designing the Service Experience [#]	
HTM 2474	Introduction to Meetings and Convention Management [#]	
HTM 2514	Catering Management [#]	
HTM 2954	Hospitality and Tourism Study Abroad [#]	
HTM 3044	Private Club Management [#]	
HTM 3244	Franchising and Ownership in the Services Industries [#]	

HTM 3424	Event Management [#]	
HTM 3954	HTM Study Abroad [#]	
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	
HTM 4434	Event and Experience Management Senior Workshop [#]	
HTM 4444	Winery Tourism [#]	
HTM 4474	Hospitality & Tourism Law [#]	
HTM 4514	Hospitality Market Data Analysis [#]	
Subtotal		27
Free Electives		
Select three hours in Free Elective credits		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by completing ENGL 2844 [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Six credit hours fulfilled by completion of required courses.		
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select three hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Three hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) fulfilled by completing FREC 2124 or GEOS 1024 [4,#]		
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [6]		3
Subtotal		34
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 GEOG 1115 Seeking Sustainability / NR 1115 Seeking Sustainability is typically offered in fall semesters only.

4 FREC 2124 Forests, Society & Climate is typically offered in spring semesters only.

5 HTM 4354 Information Technology and Social Media in Hospitality and Tourism is strongly recommended.

6 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

7 HTM 2454 Global Travel & Tourism Management can only be taken as an elective if GEOG 1115 Seeking Sustainability / NR 1115 Seeking Sustainability is chosen in Year Two- Fall Semester.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
HTM 1414	Introduction to Hospitality and Tourism Management	3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
HTM 3484	Socio-Cultural Impacts of Tourism [#]	3
HTM 2454 or GEOG 1115 or NR 1115	Global Travel & Tourism Management [3,#] or Seeking Sustainability or Seeking Sustainability	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
	Credits	**18**
Spring Semester		
HTM 3414	Chef Lab: Culinary Operations Management [#]	4
HTM 3524	Lodging Management [#]	3
Select three credit hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
ENGL 2844	Introduction to Professional and Technical Writing [#]	3
FREC 2124 or GEOS 1024	Forests, Society & Climate [4,#] or Earth Resources, Society, and Environment	3
	Credits	**16**
Third Year		
Fall Semester		
HTM 3444	Hospitality Financial Management [#]	3
MKTG 3104	Marketing Management [2,#]	3
FREC/NR/LAR 2554 or BIT 4604	Leadership for Global Sustainability [#] or Data Governance, Privacy and Ethics	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
HTM 4454	Hospitality Revenue Management [#]	3
HTM Elective [5,#]		3
MGT 3404	Principles of Management [2,#]	3
HTM 4414	Restaurant Management: Design and Innovation [#]	3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
HTM 4964	Field Study in HTM [#]	3
HTM 4464	Human Resources Management in the Hospitality Industry [#]	3
HTM Elective [#]		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**
Spring Semester		
HTM 4484 or PSCI 3344	International Tourism [#] or Global Environmental Issues: Interdisciplinary Perspectives	3
Select three credit hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MGT 4394	Strategic Management [2,#]	3
HTM SEA Elective [#]		3
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [6]		3
	Credits	**15**
	Total Credits	**125**

HTM SEA Electives

Code	Title	Credits
Choose one - 3 credit hours		
HTM 4334	Sustainable Entrepreneurship and Innovation in Hospitality & Tourism [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	3
SOC 2024	Sociology of Race and Ethnicity [#]	3
SOC 2034	Diversity and Community Engagement [#]	3

HTM Electives

Code	Title	Credits
6 credit hours needed		
HTM 2104	Careers in Hospitality and Tourism (1 credit hour course) [#]	1
HTM 2434	Hospitality Sales [#]	3
HTM 2454	Global Travel & Tourism Management [7,#]	3
HTM 2464	Designing the Service Experience [#]	3

HTM 2474	Introduction to Meetings and Convention Management [#]	3
HTM 2514	Catering Management [#]	3
HTM 2954	Hospitality and Tourism Study Abroad [#]	3
HTM 3044	Private Club Management [#]	3
HTM 3244	Franchising and Ownership in the Services Industries [#]	3
HTM 3424	Event Management [#]	3
HTM 3954	HTM Study Abroad [#]	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
HTM 4434	Event and Experience Management Senior Workshop [#]	3
HTM 4444	Winery Tourism [#]	3
HTM 4474	Hospitality & Tourism Law [#]	3
HTM 4514	Hospitality Market Data Analysis [#]	3

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] GEOG 1115 Seeking Sustainability / NR 1115 Seeking Sustainability is typically offered in fall semesters only.

[4] FREC 2124 Forests, Society & Climate is typically offered in spring semesters only.

[5] HTM 4354 Information Technology and Social Media in Hospitality and Tourism is strongly recommended.

[6] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

[7] HTM 2454 Global Travel & Tourism Management can only be taken as an elective if GEOG 1115 Seeking Sustainability / NR 1115 Seeking Sustainability is chosen in Year Two- Fall Semester.

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Management

Our Website (http://www.management.pamplin.vt.edu)

Overview

Students in the Management major are guided by world-class faculty to prepare for careers in industry-leading and highly successful organizations. Our courses build strong foundations in fundamental management processes and prepare students to drive and lead organizations to sustainable and profitable growth in an increasingly complex world. We equip students with the mindset, approaches, and tools to succeed in a global business environment and the ability to translate disruptive change into business opportunities. Our courses and curriculum emphasize critical thinking, innovative problem solving, data analytics, ethical reasoning, persuasive communication, diversity & inclusion and interpersonal and team effectiveness. These skills position Pamplin Management graduates for future success in a wide variety of high-paying careers or as entrepreneurs. We offer four majors: ,Entrepreneurship, Innovation & Technology Management (EIT), Human Resource Management (HRM) ,Management Consulting & Analytics (MCA), and Management (MGT).

Management majors add considerable value to the organizations that employ them. Great managers in any business act as force multipliers, increasing the output generated by the people they work with and the resources available to them. Management majors, their teams and their organizations do this by finding ways to help organizations work smarter. Our core curriculum helps students develop the awareness needed to identify new entrepreneurial opportunities, improve organizational processes, use analytics to support evidence-based decisions, and effectively manage projects in support of organizational change and improvement.

Students may choose to minor in Entrepreneurship and/or Organizational Leadership. Students can also participate in paid and for-credit internships, career-focused clubs and student-led extracurricular activities. An emphasis on developing employable skills is further supported by course-based and one-on-one career planning, as well as by proving mastery of skills through earning professional certifications.

Management Majors

These majors are designed to provide students critical skills targeted toward potential future career paths in the following areas.

MGT: Management

This major allows students to pave their own way through our management courses. This major supports personalized selection of emphasis. For example, students interested in Management and Sustainability can chose the Management Major and select a path of Department, College and University courses around managing sustainability issues. Students interested in Management and cybersecurity have the same option. In short, it can be a major for students with the drive to work in or for organizations and their own passion about how to do that.

EIT: Entrepreneurship, Innovation & Technology Management

Students develop an entrepreneurial mindset and the related organizational skills to identify problems that can be converted

into opportunities, attract and deploy resources in pursuit of those opportunities, and to lead through innovation in both new and established companies. This major is designed for students who are considering starting their own businesses or who want to play a key role in making existing businesses more innovative and entrepreneurial.

HRM: Human Resource Management

This major prepares general managers or individuals interested in a career in the human resources field with the knowledge and skills necessary to systematically manage people to achieve group and organizational objectives and to sustain organizational effectiveness. Students will gain knowledge and skills in areas such as HR strategy, recruitment, training & development, performance management, diversity & inclusion, and compensation & benefits. This major will not only prepare students for careers in Human Resource Management but will also equip future business managers and leaders with the talent management mindsets and tools necessary to acquire, retain, and manage people effectively.

MCA: Management Consulting & Analytics

Students develop knowledge, human-centric and analytical skills to break down complex strategic problems and develop robust and innovative solutions, enabling them to successfully pursue careers in management consulting. Critical skills and competencies taught in this major will also benefit future managers and leaders to drive success in a complex environment that relies heavily on data, analytics, project management and the power of high-performing teams.

Minors Offered Through the Department of Management

Students from majors across the university (including Management majors) may also earn any of two minors offered through the Department of Management. These minors are the Organizational Leadership minor and the Entrepreneurship - New Venture Growth minor.

Organizational Leadership Minor

The Pathways Minor in Organizational Leadership is open to all Virginia Tech students with at least a 2.5 GPA at Virginia Tech. The curriculum provides students with courses and experiences necessary to serve as more effective leaders within their organizations. Each student takes courses to improve their competencies across four areas: creativity and innovation; critical and strategic thinking; intercultural communication; and holistic thinking and ethical reasoning. Students also participate in a leadership field experience which enables them to develop areas specific to their own needs. The leadership minor consists for eighteen hours of study, including six hours of management courses, nine hours of electives, and three hours of experiential activity. As a Pathways minor, students can count courses within the minor toward a student's Pathways to General Education requirements.

Entrepreneurship - New Venture Growth Minor

The Entrepreneurship-New Venture Growth minor equips students with the knowledge and skills to create, build, and lead growth-oriented new ventures in technology-rich environments. The minor consists of eighteen credit hours of study and includes a variety of interdisciplinary courses that explore key topics such as business model design and analysis, technology/digital entrepreneurship, project management, and innovative product design and technology commercialization strategies.

- Entrepreneurship, Innovation & Technology Management Major (p. 733)
- Human Resource Management Major (p. 736)
- Management Consulting and Analytics Major (p. 739)
- Management Major (p. 741)

Head: Devi R. Gnyawali
Assistant Department Head: Ron Poff
Pamplin Professors of Management: C. E. Devers and D. R. Gnyawali
Strickler Professor: C. Porter
Professor: K.D. Carlson
Visiting Professor: B. Tyler
Associate Professors: J. B. Arthur, D. J. Beal, W. J. Becker, D. E. Hatfield, R. A. Hunt, P. Kumar, K. A. Schnatterly, D. M. Townsend and A. K. Ward Bartlett
Assistant Professors: K. S. Awate, J. E. Lewis, M. Stallkamp, P. S. Thompson, and M. L. White
Collegiate Assistant Professor:
Collegiate Associate Professor: C. M. Courtney, J.J. Simpson, and C.C Tseng
Associate Professor of Practice: L. Anderson, D. R. Buengel, R. A. Hunt, E. C. Jamison, R. Poff, and D. J. Williamson
Assistant Professor of Practice: M. E. Deck, P. Kiratikosolrak, S. Matuszak, and W. A. Schaudt
Instructors: A. L. Beleny
Affiliated Faculty: M. Singal, D. Stone, and E. Stone-Romero
Emeritus Faculty: L. D. Alexander, T. W. Bonham, A. T. Cobb, J. L. French, J. R. Lang, R. M. Madigan, S. E. Markham, K. F. Murrmann, J. F. Robinson, J. M. Shepard, W. J. Smith, C. U. Stephens L. Teagarden, and R. E. Wokutch
Career Advisor: D. C. Cordova
Business Leadership Center Director: R. A. Poff
Integrated Security Education and Research Center Director: J. J. Simpson

Undergraduate Course Descriptions (MGT)

MGT 1064 - Entrepreneurs Residence Experience (3 credits)
Introduces students in the Innovate Living Learning Community to the various aspects of the entrepreneurial ecosytem at Virginia Tech and familiarizes them with common business terminology in the field. Discover the difference between ideas and entrepreneurial opportunities and relate current business events to topics in the course, including specific entrepreneurial opportunities. Provides weekly opportunities to interact with and learn from visiting entrepreneurs through various methods (i.e. fireside chats, dinners, and speaking events) to enhance learning outside of the classroom and build confidence in engaging with seasoned professionals. Discusses entrepreneurial ideas and current opportunities and applies learning to create and deliver an effective, individual startup concept pitch.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 1104 - Foundations of Business (3 credits)
Introduces students to the free enterprise system and the various business functions, such as management, human resources, marketing, operations, accounting and finance, technology as well as to the different types of business such as manufacturing and service. Analyzes the various business functions to help improve understanding of career interests and opportunities, as well as to provide a basic understanding of how a company operates. Applies learning through a group project in which a micro-business is created and managed.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 1935 - Fundamentals of Cadet Professional Leadership (2 credits)
1935: Foundational course of the Virginia Tech Corps of Cadets Citizen-Leader Program. Explores basic business etiquette and introduces the cadet to concepts of online professional identity, basic career preparation, resume writing, basic interviewing techniques and ways to create a healthy nutrition and physical fitness program. Includes a comprehensive physical fitness laboratory. Membership in the Corps of Cadets is required. 1936: Introduces methodologies for efficient and effective leadership, explores options for multiple career paths, basic business etiquette, opportunity to attend leadership conferences and field trips to local businesses. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1936 - Fundamentals of Cadet Professional Leadership (2 credits)
1935: Foundational course of the Virginia Tech Corps of Cadets Citizen-Leader Program. Explores basic business etiquette and introduces the cadet to concepts of online professional identity, basic career preparation, resume writing, basic interviewing techniques and ways to create a healthy nutrition and physical fitness program. Includes a comprehensive physical fitness laboratory. Membership in the Corps of Cadets is required. 1936: Introduces methodologies for efficient and effective leadership, explores options for multiple career paths, basic business etiquette, opportunity to attend leadership conferences and field trips to local businesses. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1945 - Fundamentals of Cadet Leadership (2 credits)
Foundational course of the Virginia Tech Corps of Cadet Leader Development Program. Explores self-understanding, personality types, active and passive followership, leadership and ethical theories. A laboratory introduces freshmen cadets to academic success strategies. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1946 - Fundamentals of Cadet Leadership (2 credits)
Continued emphasis on self-understanding and followership. Introduces adversarial and positive leadership models, hazing statutes and leadership case studies. Prepares cadets for leadership positions in their sophomore year. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2064 - Foundations of Entrepreneurship (3 credits)
Introduction to the study and practice of entrepreneurship in a human-centered context. Examination of the influence of different cultures, institutions, and global factors and the role of human values, beliefs and behaviors on modes of entrepreneurial action. Application of theories and methods of entrepreneurial opportunity identification within the contexts of human behavior, social institutions and/or patterns of culture to generate ideas for new ventures and application of design-thinking theories and concepts in a field-based, experiential learning project to design, iterate and validate a value proposition and business model for a new venture.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2104 - Careers in Management (1 credit)
Career opportunities associated with the Management major's three options: Human Resource Management (HRM), Management Consulting and Analytics (MCA), and Entrepreneurship, Innovation and Technology (EIT). Analyzes the current job markets and opportunities for these career paths. Creating effective resumes and cover letters and researching and networking with targeted firms. Experience scenarios of informational, behavioral, case interviews, and elevator pitch presentations. Incorporate real life perspective through guest speakers who are industry experts and local field visits. Pre: Sophomore and Junior Management majors and business undecided only. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2114 - Principles of Project Management (3 credits)
Broad and comprehensive overview of project management (PM) with emphasis on its application in organizations. Tools, techniques, and evaluative frameworks that are intended to solve problems and execute organizational strategy. Emphasizes project lifecycle and introduces multiple PM approaches and technologies. Change management evaluation and project manager role in implementing related strategies. Assessment of project financial performance, impact, and risk.
Prerequisite(s): MGT 1064 or MGT 1104
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2204 - Global Business of Pop Culture (3 credits)
Analyze the global business of pop culture through a semester-long case study of a selected pop culture industry. Investigate how social, historical, political, and economic forces shape, and are shaped by, business-decision making at local and global scales. Emphasis on business-decision making by pop culture entities reflecting how they have (or have not) responded over time to changing power dynamics and inequity in the macroenvironment (e.g., reimagined social identities and expectations, accelerated globalization and market access, political unrest, etc.). Use project-based learning to assess past strategic decisions from multiple, intersecting perspectives (e.g., social, historical, political, economic, etc.) and make recommendations about market-based decisions.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2314 - Introduction to International Business (3 credits)
Fundamental concepts of international business. International business environment and how it affects decisions, the creation of competitive advantage in the multinational firm, and complexities of managing it. Why international businesses exist, drivers of international expansion, differences among countries in terms of political, legal, economic, technological and cultural dimensions, and the complexity of international business decisions. Causes and consequences of globalization, international trade, and analyzing the challenges of managing international business, with a focus on a number of industries, including hospitality and tourism. Operational, strategic, and ethical issues which are unique to multinational corporations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HTM 2314

MGT 2354 - Teams, Leadership, and Business: Cultivating Excellence (3 credits)
Explores a broad range of concepts and theories important for a basic understanding of team leadership, including organizational behavior, motivation, conflict management, business engagement and stakeholders. Semester-long, service-learning assignment and case analyses to evaluate practical applications of exceptional leadership practices and team skills. Examines different cultures and values found within a team and business and challenges of diversity and inclusion in team settings. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2504 - Sustainable Business Management (3 credits)
Foundational study and practice of sustainability and social issues in a business management context. Uses the emerging environmental, social, and governance (ESG) framework to explore the historical context of sustainability in business, influential ESG stakeholders, business commitments towards "net zero" status, business' role in creating and mitigating environmental impact of greenhouse gas emissions (GHG's), profitability of sustainable businesses, relevant government policy and regulation, ESG measurement and reporting, innovation and competitive advantage, sustainable supply chain management, sustainable business models, embedding sustainability into strategy, and how managers conceptualize and initiate ESG programming.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2614 - Foundations of Management Consulting and Data Analytics (3 credits)
Provides students with a fundamental understanding of management consulting as an industry, the consulting process, and success-factors for providing value-adding consulting services. Examines financial and other key concepts that successful management consultants need to master to provide insight and value to their customers. Provides a comprehensive overview of new and emerging technologies impacting the consulting industry and consulting skills in data analytics, data sense-making and data visualization.
Prerequisite(s): MGT 1104 or MGT 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 2935 - Career Planning for Cadets (2 credits)
2935: Cadets in this class learn the basic of business networking, developing presentations, professional mentorship, personal finance, and investments, advanced nutrition and living a healthy lifestyle. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 2936 - Career Planning for Cadets (2 credits)
2936: Cadets in the class learn about careers in public service, leadership through service learning, personal investment strategies, ethical business leadership, explore opportunities for public service, and participate in leadership conference. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 2945 - Small Unit Leadership for Cadets (1 credit)
Prepares cadets for responsibilities as small unit leaders. Builds on the previous years knowledge to focus on skills and knowledge necessary to lead small units. Introduces cadets to the importance of communication, includes basic counseling techniques, disciplinary actions, conflict resolution, cadet regulations and leadership case studies. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2946 - Small Unit Leadership for Cadets (1 credit)
Prepares cadets for organizational leadership. Teaches skills and knowledge necessary to effectively lead a mid- level organization. Includes practical counseling techniques using the cadet counseling form, the leaders toolbox, the cadet disciplinary system, mentor program, and conflict resolution. Includes instruction on the Senior Sergeant Selection Process. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to take management-related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

MGT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

MGT 2984O - Special Study (1-19 credits)
Pathway Concept Area(s): 5F Quant & Comp Thnk Found.
Instructional Contact Hours: Variable credit course

MGT 3064 - Cornerstones of Entrepreneurship and Innovation (3 credits)
Provides a cornerstone foundation for the understanding of entrepreneurship and the business innovation process exposing students to fundamental business concepts applied and integrated in these arenas. An examination of value creation through entrepreneurship and the rudiments of new ventures are provided helping students develop an entrepreneurial frame of mind and perspective. Pre: Completion of 45 credit hours and two CLE Area 5 courses.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3074 - Social Entrepreneurship (3 credits)
Provides a foundation for how social entrepreneurs use and combine resources to pursue opportunities that lead to social change and/or address social needs. An examination of the nature of social entrepreneurship and its various practices is provided, helping students develop an entrepreneurial frame of mind and prepare them to act as effective leaders of social change.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3084 - Digital Entrepreneurship, Innovation, and Product Development (3 credits)
Technology-based and digital entrepreneurship in startups, corporate, and public-sector organizations. Course activities in commercialization and resource mobilization strategies for the development of new digital technologies. Data-driven assessment and pursuit of entrepreneurial opportunities in digital environments, including cybersecurity, artificial intelligence, blockchain technologies, biotechnology, and other emerging new technologies.
Prerequisite(s): MGT 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3094 - Global Entrepreneurship (3 credits)
Global entrepreneurship and venture creation strategies in intercultural global perspectives. Identifies the global entrepreneurial core competencies, applies formal global thinking concepts, and uses integrative problem-solving tools in global entrepreneurial opportunity contexts. Analyze the value proposition of a new venture model across national boundaries. Builds framework for understanding the entrepreneurial process in global contexts. Blends theory with practical experiences in global business contexts to explore and research global entrepreneurial process and environment.
Prerequisite(s): MGT 2064
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3304 - Management Theory and Leadership Practice (3 credits)
Introduces the student to a broad range of concepts, theories and practices important for a basic understanding of management. Includes the functions of management, roles of managers in organizations, and tools and techniques for managing organizational performance. Focus on the global environment in which today's managers must effectively and ethically lead organizations. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3324 - Organization Behavior (3 credits)
This course examines the determinants and consequences of human behavior in formal organizations. Specific focus is on the individual, interpersonal, and group processes which underlie all the human dynamics.
Corequisite(s): 3304 or 3404.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3334 - Managing Human Resources (3 credits)
Examines the strategies, policies, and practices associated with effectively managing human resources. Designed to provide future managers with tools and techniques to acquire, develop, reward, and retain employees within the legal and social context of todays organizations. Emphasizes how managing human resources can contribute to organizational effectiveness in a variety of industrial and organizational settings.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3344 - Employee & Labor Relations Law, Bargaining, and Dispute Resolution (3 credits)
Historical, legal, social, and economic forces that shape employment relationships in the U.S. Labor and employment laws and how they apply in specific cases. Anticipate and respond to a union organizing campaign. Employment contract bargaining and dispute resolution in union and nonunion settings. Compare U.S. private sector, public sector, and international employee and labor relations laws and institutions. Debate contemporary employee relations' events and issues using critical thinking and ethical reasoning.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3404 - Principles of Management (3 credits)
Management concepts, theories, and practices for the effective and successful operation of modern organizations. Four functions of management and the activities involved in each function. Importance of ethical management practices in the effective operation of global business organizations, including entrepreneurial ventures. Individuals and group behaviors in the workplace, as well as methods to improve workplace performance.Duplicates some material in MGT 3304. Course credit will not be awarded for both MGT 3304 and MGT 3404.
Prerequisite(s): MGT 1104 or MGT 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3414 - Talent and Organizational Development (3 credits)
Talent development systems and their strategic support of organizational learning, performance management process, a high-performing workforce, and organizational success. Foundational elements of talent development, including performance management process equity in evaluation and interviews. Emerging talent and organizational development trends and technologies. Talent development and performance management analytics to identify organizational talent capacity to meet current and future workplace needs. Organizational and talent development learning plans within talent-centered cultures in diverse organizational contexts. Emerging issues in learning, performance management, and talent development. Client projects, guest speakers from the field, and contemporary case studies.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3424 - Strategic Talent Planning, Acquisition, and Analytics (3 credits)
Strategic talent planning, acquisition, and analytics within organizations. Alignment of talent planning and acquisition strategies with legal and social contexts, organizational goals, equity, and firm performance. Identification and analysis of key human capital data to inform talent acquisition decisions. Impact of talent planning decisions on acquisition and selection decisions, job design, internal workforce mobility, retention and succession planning for immediate and long-term outcomes. Emerging trends impacting field of human resources and specific to these topics.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3444 - Multicultural Diversity in Organizations (3 credits)
Evaluates the impact of multicultural diversity on the employees work experience and on organizational processes/ performance. Students analyze and discuss theories and practices related to the business case for diversity, exploring the processes through which multicultural diversity (both domestic and international) affects the organization and its stakeholders. Topics include multicultural diversity theories, legislation, interpersonal and international differences, cultural intelligence, and organizational practices. Pre: Junior Standing. (3H,3C)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3604 - Managerial Analytics (3 credits)
Digital tools to analyze managerial data ranging from productivity data to large scale, organizational databases. Three themes: (1) analyzing and improving productivity using digital tools; (2) applying exploratory data tools; (3) improving organizational collaboration, analysis, and knowledge sharing using relational databases.
Corequisite(s): 3304 or 3404.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3614 - Strategy and Competition Analytics (3 credits)
Develops concepts and techniques for analyzing and formulating strategy in a variety of business environments. Focuses on research, data, and analysis related to the key players in the environment from both a competitive and cooperative perspective. Basic frameworks for analysis include mapping the objectives and constraints of the players, and modeling the pattern of interaction among the players. Provides an in-depth exposure to the theory and tools of strategy analysis and practice in their management consulting application.
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 3754 - Management Internships and Career Development (3 credits)
Guided experience in work environments and job search. Through unpaid internships, students have the opportunity to view the inner workings of businesses first hand while working on organizationally meaningful assignments. Class activities prepare students for conducting effective job searches.
Prerequisite(s): MGT 3304 or MGT 3404
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MGT 3804 - Topics for Cadet Global Leadership Studies (3 credits)
Analyzes historic and current leadership challenges using specific military campaigns for context. Covers national and military objectives and various instruments of national power in relation to national security. Travel to relevant country and battlefields for experiential learning. May be repeated with different content for a maximum of six (6) credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

MGT 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3874, PSCI 3874

MGT 3935 - Advanced Professional Development for Cadets (2 credits)
3935: Cadets in this learn about the mentor-protege relationship; resolving team conflicts; diversity in the workplace; standards of business conduct, dining etiquette; and maintaining a healthy lifestyle. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 3936 - Advanced Professional Development for Cadets (2 credits)
3936: Cadets in the class learn about business challenges from panels of experts in various career fields, business problem solving, speaking before a business audience, business writing, preparing for an internship and participation in a leadership conference. A physical fitness laboratory complements the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 3945 - Cadet Organizational Leadership (1 credit)
Prepares junior class cadets for responsibilities as senior sergeants. Builds on the previous years knowledge of small unit leadership. Introduces cadets to decision making, writing decision papers/executive summaries, project management, public speaking, and refinement of their personal leadership philosophy. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 3946 - Cadet Organizational Leadership (1 credit)
Prepares junior calss cadets for the role of responsibility they will assume as senior leaders in the Corps. Continues focus on organizational leadership and introduces cadets to command and a commanders responsibilities. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4064 - Developing Entrepreneurial Ventures (3 credits)
Takes a cross-functional perspective on identifying and evaluating entrepreneurial opportunities, developing new ventures, and pursuing new venture strategies to compete in the marketplace. Explores business potentials of new venture ideas, examines new ventures feasibility, and develops business planning tools for the venture. Pre: Senior Standing.
Prerequisite(s): MGT 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4084 - Management Consulting (3 credits)
Hands-on application of accounting, finance, marketing, management, information technology, and project management to actual business clients through on-site consultation with start-up and existing businesses and non-profits. Through classroom instruction, instructor coaching, and experiential studies, students will use the skills they have learned over several semesters to explore the field of management consulting. For the Management major with senior standing in the Management Consulting Option.
Prerequisite(s): MGT 3304 or MGT 3404 and MGT 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGE 4094, IDS 4094

MGT 4314 - International Management (3 credits)
The course is designed to provide the student with familiarity concerning the unique problems, characteristics, and demands that face multinational managers and the international business community. Junior standing required.
Prerequisite(s): MGT 2314 or HTM 2314
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4324 - Business and Professional Ethics (3 credits)
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 4324

MGT 4334 - Ethical Leadership and Corporate Social Responsibility (3 credits)
Focus on the leadership role of managers in promoting ethics and corporate social responsibility in business today. Consideration of the overall role of business in society and specific business-society issues such as equity and identity at work, environmental pollution, consumer and employee concerns, corporate-community relations, and the activities of multinational corporations. Issues examined through conceptual frameworks of business ethics, corporate social responsibility, and leadership (especially servant leadership). Emphasis placed on students articulating analysis of such issues through written and oral communication.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4344 - Productivity and Quality Leadership (3 credits)
This course provides an introduction to leadership in the context of productivity and quality improvement. It focuses on understanding the concepts and skills associated with contemporary management strategies and systems. This course requires active student involvement and emphasizes participative leadership skills, data collection, qualitative problem solving, and communication processes. For Management majors only. Senior standing required.
Prerequisite(s): MGT 3304 or MGT 3404 and MGT 3324 and MGT 3604 and BIT 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4354 - Leadership: Advances in Skills and Concepts (3 credits)
This cornerstone course provides cutting-edge experiences, skills, and knowledge in leadership for students in the leadership minor. Within an historical context that balances military, political, and business perspectives, four types of leadership will be examined: self-leadership, dyadic leadership, team leadership, and enterprise leadership. Special emphasis will be placed on the specific skills, such as computer literacy and project management, required for leaders to succeed in modern, technologically oriented organizations. Pre: Senior standing.
Prerequisite(s): MGT 2354 or MGT 3304 or MGT 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4394 - Strategic Management (3 credits)
Senior-level capstone course to formulate and implement strategies to create and sustain competitive advantage. Emphasis on developing pragmatic and action-oriented general management skills that integrate across functional areas of the organization. Utilize various tools, concepts, and analytical framework to define and analyze strategic problems. Revisits business principles and practices covered in basic business courses. Pre: Senior standing.
Prerequisite(s): (MGT 3304 or MGT 3404) and (MKTG 3104 or MKTG 3104H) and FIN 3104 and BIT 3414
Corequisite(s): FIN 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4414 - Strategic Compensation, Benefits, and Rewards (3 credits)
Strategic perspective on how decisions about employee compensation, benefits, and rewards help firms to implement business strategy and achieve competitive advantage. Basic compensation tools and analytic techniques used to design an internally aligned and externally competitive pay system in organizations. Individual and group level performance-based rewards that drive performance and achieve business objectives. Strategic choice of employee benefits aligned with organizational goals. Compensation-related laws and analysis of compensation data to ensure equity and legal compliance.
Prerequisite(s): MGT 3334 or MGT 3344 or MGT 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

MGT 4854 - Analytics in Action (3 credits)
Problem-solving framework and analytic techniques for solving messy, unstructured, high-impact, real-world organizational/societal problems within an interdisciplinary, intercultural, experiential learning context. Definition of problem scope, objectives, need for change, ethical concerns, and diversity and inclusion issues; identification of stakeholders and their values; evaluation of decision tradeoffs; problem decomposition and hypothesis formulation; project planning and administration; data versus user requirements, ethical and inclusive decision making, data collection, preparation, and analysis; team roles and management; professional communication of insights, policy and action recommendations.
Corequisite(s): BDS 2005, CMDA 2014
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4854

MGT 4935 - Cadet Citizen Leader Practicum (2 credits)
4935:Students in the class learn practical strategies for leading teams to plan execute a project; project writing; applied dining etiquette; being a mentor to others, leadership through service learning and living a healthy lifestyle. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 4936 - Cadet Citizen Leader Practicum (2 credits)
4936: Students in the class begin the process of transition from college to their intended career. Topics include conduct of effective meetings, salary and benefits negotiation, obtaining post-graduation professional development, serving as a mentor, and developing a plan for the first six months in a new job. A physical fitness laboratory compliments the lecture. Membership in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MGT 4944 - Leading in Your Profession (1 credit)
Examines the skills and knowledge necessary to succeed in a responsible role of leadership when beginning ones career. It is a capstone course that draws on the leadership training and experience cadets have accumulated during their first three years in the Corps of Cadets. Senior standing in the Corps of Cadets required. Course may be taken twice for credit. The pre-requisite requirement is such that a student must take the pre-requisite twice before enrolling in this course.
Prerequisite(s): MGT 2944
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

MGT 4945 - Executive Leadership for Cadets (1 credit)
Examines executive level leadership. It explores executive decision making, constraint theory and problem solving in both the military and civilian career fields. Senior standing in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 4946 - Executive Leadership for Cadets (1 credit)
Prepares senior class cadets for the transition from college to career professional. Explores life planning, personal finance, taking charge in a new organization, cross- generational communication, and developing subordinate relationships. Senior standing in the Corps of Cadets is required.
Instructional Contact Hours: (1 Lec, 1 Crd)

MGT 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MGT 4994H - Undergraduate Research (1-19 credits)
Honors section
Instructional Contact Hours: Variable credit course

Entrepreneurship, Innovation & Technology Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 2104	Careers in Management	1
MGT 2064	Foundations of Entrepreneurship [#]	3
MGT 2114	Principles of Project Management [4,#]	3
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	3
MGT 3324	Organization Behavior [#]	3
MGT 3404	Principles of Management [2,#]	3
MGT 3604	Managerial Analytics [#]	3
MGT 4064	Developing Entrepreneurial Ventures [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [3,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Select one of the following:		3
MGT 3074	Social Entrepreneurship [#]	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	
MGT 3094	Global Entrepreneurship [#]	
EIT Electives [#]		
Select three courses from the EIT Electives list. [#]		9
Subtotal		49
Free Electives		
Complete 18 credit hours of free electives.		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing [3]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing [3]	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by COMM 2004 or MGT 4334 (see footnote 3) [3]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credit hours from Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credit hours from Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4

BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credit hours of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) is fulfilled by completing MGT 2064.		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) is fulfilled by completing MGT 4334.		
Subtotal		37
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Entrepreneurship, Innovation, & Technology majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills - COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

4 Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Entrepreneurship, Innovation, & Technology may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

EIT Electives

Code	Title	Credits
ENGE 2094	Create!: Ideation & Innovation #	3
MGT 3074	Social Entrepreneurship (if not taken to satisfy major requirement) #	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development (if not taken to satisfy major requirement) #	3
MGT 3094	Global Entrepreneurship (if not taken to satisfy major requirement) #	3
MGT 3164	#	3
MGT 3954	Study Abroad (only satisfies major requirement when the topic is "Entrepreneurship") #	1-19
or MGT 4954	Study Abroad	
ENGE/IDS/MGT 4094	Startup: Commercialization of Innovation #	3
MGT 4964	Field Study (only satisfies major requirement when the topic is "Entrepreneurship") #	1-19

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (https://pamplin.vt.edu/undergraduate-programs/advising/academic-policies.html)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 or higher and an in-major GPA of 2.0 or higher to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully

complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to Undergraduate Catalog for details.

Roadmap

First Year

Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing [3] or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing [3] or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 2104	Careers in Management	1
	Credits	**16**

Second Year

Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
MGT 3404	Principles of Management [2,#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**18**
Spring Semester		
MGT 3324	Organization Behavior [#]	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
MGT 2114	Principles of Project Management [4,#]	3
Select one of the following:		3
MGT 3074	Social Entrepreneurship [#]	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	
MGT 3094	Global Entrepreneurship [#]	
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**

Third Year

Fall Semester		
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [3,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
MGT 3604	Managerial Analytics [#]	3
MKTG 3104	Marketing Management [2,#]	3
EIT Elective [#]		3
Free Elective		3
	Credits	**15**

Fourth Year

Fall Semester		
MGT 4064	Developing Entrepreneurial Ventures [#]	3
EIT Elective [#]		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
MGT 4394	Strategic Management [2,#]	3
EIT Elective [#]		3
Free Elective		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Entrepreneurship, Innovation, & Technology majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills - COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

[4] Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Entrepreneurship, Innovation, & Technology may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

[#] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

EIT Electives

Code	Title	Credits
ENGE 2094	Create!: Ideation & Innovation [#]	3
MGT 3074	Social Entrepreneurship (if not taken to satisfy major requirement) [#]	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development (if not taken to satisfy major requirement) [#]	3
MGT 3094	Global Entrepreneurship (if not taken to satisfy major requirement) [#]	3
MGT 3164	[#]	3
MGT 3954	Study Abroad (only satisfies major requirement when the topic is "Entrepreneurship") [#]	1-19
or MGT 4954	Study Abroad	
ENGE/IDS/MGT 4094	Startup: Commercialization of Innovation [#]	3
MGT 4964	Field Study (only satisfies major requirement when the topic is "Entrepreneurship") [#]	1-19

[1] **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] **Graduation Requirement:** Students must achieve a grade of **C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] COMM 2004 Public Speaking: Public Speaking is required for all Entrepreneurship, Innovation, and Technology majors who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills: Communication Skills. If ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills-COMM 1016 Communication Skills are taken, student may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

[4] Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

[5] **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 or higher and an in-major GPA of 2.0 or higher to graduate. Courses used to calculate the in-major GPA are noted.

EIT Electives

Code	Title	Credits
ENGE 2094	Create!: Ideation & Innovation [1]	3
MGT 3074	Social Entrepreneurship [1]	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [1]	3
MGT 3094	Global Entrepreneurship [1]	3
MGT 3164	[1]	3
MGT 3954	Study Abroad [1]	1-19
MGT 4094	Startup: Commercialization of Innovation [1]	3
MGT 4964	Field Study [1]	1-19

[1] **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 or higher and an in-major GPA of 2.0 or higher to graduate. Courses used to calculate the in-major GPA are noted.

Human Resource Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 2104	Careers in Management	1
MGT 2114	Principles of Project Management [5,#]	3
MGT 3324	Organization Behavior [#]	3
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution [4,#]	3
MGT 3404	Principles of Management [2,#]	3

MGT 3414	Talent and Organizational Development [#]	3
MGT 3424	Strategic Talent Planning, Acquisition, and Analytics [#]	3
MGT 3604	Managerial Analytics [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	3
MGT 4344	Productivity and Quality Leadership [#]	3
MGT 4414	Strategic Compensation, Benefits, and Rewards [6,#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
MHR Electives [#]		
Select one MHR elective. [#]		3
Subtotal		46
Free Electives		
Select remaining credits required for degree:		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F) [3]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F) [3]	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled by MGT 4334 or COMM 2004 [3]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select 3 credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by MGT 4334		
Subtotal		40
Total Credits		**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] COMM 2004 Public Speaking is required for Human Resource Management majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills - COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

[4] Offered only in fall semesters.

[5] Business Information Technology (BIT) majors who are double majoring in Human Resource Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

[6] Offered only in spring semesters.

[#] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

MHR Electives

Code	Title	Credits
MGT 2614	Foundations of Management Consulting and Data Analytics [#]	3
MGT 2504	Sustainable Business Management [#]	3
MGT 3444	Multicultural Diversity in Organizations [#]	3
MGT 4314	International Management [#]	3
MGT 4354	Leadership: Advances in Skills and Concepts [#]	3

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/).

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1, 2]	3
MATH 1524	Business Calculus [1, 2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing [3] or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1, 2]	3
ECON 2005	Principles of Economics [1, 2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing [3] or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 2104	Careers in Management	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1, 2]	3
ECON 2006	Principles of Economics [1, 2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1, 2]	3
MGT 3404	Principles of Management [2, #]	3
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution [4, #]	3
	Credits	**15**
Spring Semester		
MGT 3324	Organization Behavior [#]	3
MGT 3604	Managerial Analytics [#]	3
MGT 2114	Principles of Project Management [5,#]	3
MGT 3414	Talent and Organizational Development [#]	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
	Credits	**15**
Third Year		
Fall Semester		
MKTG 3104	Marketing Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
MGT 3424	Strategic Talent Planning, Acquisition, and Analytics [#]	3
MHR Elective [#]		3
	Credits	**15**
Spring Semester		
MGT 4414	Strategic Compensation, Benefits, and Rewards [6,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Free Elective		3
Free Elective		3
	Credits	**18**
Spring Semester		
MGT 4344	Productivity and Quality Leadership [#]	3
MGT 4394	Strategic Management [2,#]	3
Free Elective		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of

enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Human Resource Management majors who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing-ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills-COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

4 Offered only in fall semesters.

5 Business Information Technology (BIT) majors who are double majoring in Human Resource Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

6 Offered only in spring semesters

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

MHR Electives

Code	Title	Credits
MGT 2614	Foundations of Management Consulting and Data Analytics #	3
MGT 2504	Sustainable Business Management #	3
MGT 3444	Multicultural Diversity in Organizations #	3
MGT 4314	International Management #	3
MGT 4354	Leadership: Advances in Skills and Concepts #	3

Management Consulting and Analytics Major

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 2104	Careers in Management	1
MGT 2114	Principles of Project Management [4,#]	3
MGT 2504	Sustainable Business Management #	3
MGT 2614	Foundations of Management Consulting and Data Analytics #	3
MGT 3324	Organization Behavior #	3
MGT 3404	Principles of Management [2,#]	3
MGT 3604	Managerial Analytics #	3
MGT 3614	Strategy and Competition Analytics #	3
MGT 4084	Management Consulting #	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility #	3
MGT 4344	Productivity and Quality Leadership #	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
MCA Elective #		
Select one course from the MCA Electives list below. #		3
Subtotal		46
Free Electives		
Select 18 credit hours of free elective.		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing [3]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing [3]	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) can be fulfilled by COMM 2004 or MGT 4334 (see footnote 3) [3]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3

Select 3 credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) can be satisfied by MGT 4334 major requirement.	
Subtotal	40
Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Management Consulting & Analytics majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking is required.

4 Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management Consulting & Analytics (MCA) may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

MCA Electives

Code	Title	Credits
FIN 3134	Financial Analytics #	3
MGT 2064	Foundations of Entrepreneurship #	3
MGT 3334	Managing Human Resources #	3
MGT 3444	Multicultural Diversity in Organizations #	3
MGT 4314	International Management #	3
MGT 4354	Leadership: Advances in Skills and Concepts #	3
MGT/BIT 4854	Analytics in Action #	3

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count towards the minimum credit hours required for graduation. Please refer to Undergraduate Catalog for details.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 or higher and an in-major GPA of 2.0 or higher to graduate.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (https://pamplin.vt.edu/undergraduate-programs/advising/academic-policies.html).

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing [3] or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing [3] or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 2104	Careers in Management	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3

ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
MGT 3404	Principles of Management [2,#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**18**
Spring Semester		
MGT 2504	Sustainable Business Management [#]	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
MGT 2114	Principles of Project Management [4,#]	3
MGT 2614	Foundations of Management Consulting and Data Analytics [#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Third Year		
Fall Semester		
MGT 3604	Managerial Analytics [#]	3
MGT 3324	Organization Behavior [#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
MCA Elective [#]		3
FIN 3104	Introduction to Finance [2,#]	3
	Credits	**15**
Spring Semester		
MGT 3614	Strategy and Competition Analytics [#]	3
MKTG 3104	Marketing Management [2,#]	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Free Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
MGT 4084	Management Consulting [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
MGT 4344	Productivity and Quality Leadership [#]	3
MGT 4394	Strategic Management [2,#]	3
Free Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Management Consulting & Analytics majors who did not take COMM 1015 Communication Skills-COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking is required.

4 Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management Consulting & Analytics (MCA) may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

MCA Electives

Code	Title	Credits
FIN 3134	Financial Analytics [#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
MGT 3334	Managing Human Resources [#]	3
MGT 3444	Multicultural Diversity in Organizations [#]	3
MGT 4314	International Management [#]	3
MGT 4354	Leadership: Advances in Skills and Concepts [#]	3
MGT/BIT 4854	Analytics in Action [#]	3

Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314 or MGT 2314	Introduction to International Business [2] Introduction to International Business	3
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		

ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
MGT 2104	Careers in Management	1
MGT 2114	Principles of Project Management [4,#]	3
MGT 2504	Sustainable Business Management [#]	3
MGT 2614	Foundations of Management Consulting and Data Analytics [#]	3
MGT 3324	Organization Behavior [#]	3
MGT 3334	Managing Human Resources [#]	3
MGT 3404	Principles of Management [2,#]	3
MGT 3604	Managerial Analytics [#]	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility [3,#]	3
MGT 4344	Productivity and Quality Leadership [#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
MGT Electives [#]		
Select three MGT electives from the MGT Electives table. [#]		9
Subtotal		52
Free Electives		
Select remaining credits required for the degree.		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F) [3]	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F) [3]	3
or COMM 1016	Communication Skills	
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) is fulfilled by COMM 2004 or MGT 4334 (see footnote 3) [3]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) fulfilled by completing MGT 2064		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled by completing MGT 4334		
Subtotal		37
Total Credits		**125**

MGT Electives (choose three - 9 credit hours)

Code	Title	Credits
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	3
MGT 3074	Social Entrepreneurship [#]	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	3
MGT 3094	Global Entrepreneurship [#]	3
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution (fall only) [#]	3
MGT 3424	Strategic Talent Planning, Acquisition, and Analytics (spring only) [#]	3
MGT 3614	Strategy and Competition Analytics [#]	3
MGT 4064	Developing Entrepreneurial Ventures [#]	3
MGT 4084	Management Consulting [#]	3
MGT 4314	International Management [#]	3
MGT 4414	Strategic Compensation, Benefits, and Rewards (spring only) [#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] COMM 2004 Public Speaking is required for Management majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills - COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

[4] Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation . Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing [3] or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing [3] or Communication Skills	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
MGT 2104	Careers in Management	1
	Credits	**16**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
MGT 3404	Principles of Management [2,#]	3
MGT 2114	Principles of Project Management [4,#]	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**18**
Spring Semester		
MGT 2504	Sustainable Business Management [#]	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
MGT 3334	Managing Human Resources [#]	3
MGT 2614	Foundations of Management Consulting and Data Analytics [#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
	Credits	**15**
Third Year		
Fall Semester		
MGT 3604	Managerial Analytics [#]	3
MGT 3324	Organization Behavior [#]	3
FIN 3104	Introduction to Finance [2,#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
	Credits	**15**
Spring Semester		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
MGT Elective [#]		3
MGT Elective [#]		3
MKTG 3104	Marketing Management [2,#]	3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3

MGT 4334	Ethical Leadership and Corporate Social Responsibility [3,#]	3
MGT Elective [#]		3
Free Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
MGT 4344	Productivity and Quality Leadership [#]	3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

MGT Electives (choose three - 9 credit hours)

Code	Title	Credits
MGT 3064	Cornerstones of Entrepreneurship and Innovation [#]	3
MGT 3074	Social Entrepreneurship [#]	3
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development [#]	3
MGT 3094	Global Entrepreneurship [#]	3
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution (fall only) [#]	3
MGT 3424	Strategic Talent Planning, Acquisition, and Analytics (spring only) [#]	3
MGT 3614	Strategy and Competition Analytics [#]	3
MGT 4064	Developing Entrepreneurial Ventures [#]	3
MGT 4084	Management Consulting [#]	3
MGT 4314	International Management [#]	3
MGT 4414	Strategic Compensation, Benefits, and Rewards (spring only) [#]	3

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Management majors who did not take COMM 1015 Communication Skills - COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing - ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1A: Advanced Discourse requirement. If COMM 1015 Communication Skills - COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the 1A requirement.

4 Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

1 **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 **Graduation Requirement**: Students must achieve a **grade of C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business/MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 COMM 2004 Public Speaking is required for Management majors who did not take COMM 1015 Communication Skills and COMM 1016 Communication Skills. If ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing are taken, COMM 2004 Public Speaking will satisfy the Pathway 1a requirement. If COMM 1015 Communication Skills and COMM 1016 Communication Skills are taken, students may use MGT 4334 Ethical Leadership and Corporate Social Responsibility to satisfy the Pathway 1a requirement.

4 Business Information Technology (BIT) and Cybersecurity Management and Analytics (CMA) majors who are double majoring in Management may substitute BIT 4484 Project Management for MGT 2114 Principles of Project Management.

MGT Electives

Code	Title	Credits
Entrepreneurship, Innovation, and Technology Track		
MGT 3064	Cornerstones of Entrepreneurship and Innovation	3
MGT 4064	Developing Entrepreneurial Ventures	3
Select one of the following:		
MGT 3074	Social Entrepreneurship	
MGT 3084	Digital Entrepreneurship, Innovation, and Product Development	
MGT 3094	Global Entrepreneurship	
Management Consulting and Analytics Track		
MGT 3614	Strategy and Competition Analytics	3
MGT 4084	Management Consulting	3
MGT 4314	International Management	3
Human Resource Management Track		
MGT 3344	Employee & Labor Relations Law, Bargaining, and Dispute Resolution	3
MGT 3424	Strategic Talent Planning, Acquisition, and Analytics	3
MGT 4414	Strategic Compensation, Benefits, and Rewards	3

MGT courses which can be taken as free electives:

Code	Title	Credits
MGT 2404		
MGT 2984	Special Study	1-19
MGT 3014		
MGT 3444	Multicultural Diversity in Organizations	3
MGT 3754	Management Internships and Career Development	3
MGT 3954	Study Abroad	1-19
MGT 3984	Special Study	1-19
MGT 4094	Startup: Commercialization of Innovation	3
MGT 4964	Field Study	1-19
MGT 4984	Special Study	1-19

Any additional management courses (including those listed as MGT Electives) can be taken as free electives once major requirements are satisfied.

Marketing

Our Website (http://www.marketing.pamplin.vt.edu)

Overview

Marketing grows out of the concept of exchange between buyers and sellers. Driven by the needs and wants of the consumer, marketing managers develop new products, assign effective price levels, create promotional strategies, and develop the best distribution plans to guarantee that products reach the final consumer. Marketing also plays a crucial role in managing the efficient flow of goods and services from businesses to businesses. And managing marketing is growing even more exciting as technology and the internet enable managers to stay in closer contact with their customers and better manage this relationship. Marketing by manufacturing firms is well-known. Service industries such as banking and health care, however, are increasingly relying on marketing to improve service quality and delivery. Non-profit organizations, such as Habitat for Humanity and the American Red Cross, also use marketing to deliver social goods and services. All of these organizations benefit when they are able to use marketing concepts and tools to better understand their clients and design unique offerings that can meet their clients' needs.

The undergraduate program in marketing management is designed to offer the student a broad business education with an emphasis on professional training for development of marketing strategies and managing marketing operations. Virginia Tech Marketing graduates pursue a range of careers. They take jobs in marketing management, sales, advertising, retailing, and consulting positions in companies small and large. The curriculum is designed to provide core skills in marketing and to support this broad range of potential career interests.

In addition to the undergraduate program, the faculty in marketing management offer a master's and a doctoral degree for those students interested in more technical positions, such as marketing research; more rapid promotion with certain employers; or positions in higher education.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment.

The Marketing Department currently offers three degree options: Marketing- no concentration, Marketing- Sales concentration, and Marketing- Digital Marketing Strategy Concentration. In addition to the major, Marketing offers minors in Professional Sales and Digital Marketing Strategy to non-Marketing majors within the College of Business only.

The Professional Sales concentration and minor provide students with the knowledge and skills necessary to successfully enter the field of professional sales. Students will learn the necessary knowledge and skills needed to compete successfully in the respective field.

The Digital Marketing Strategy Concentration and minor provides students with the knowledge and skills to enter Marketing and related fields with technical experience in Digital Product delivery and developing, analyzing, and enhancing firms' products on the web, mobile, and social networks.

- Marketing Management Major (p. 748)
- Marketing Management Major with Digital Marketing Strategy Option (p. 751)
- Marketing Management Major with Professional Sales Option (p. 755)

Department Head: Rajesh Bagchi
Richard E. Sorensen Junior Faculty Fellow and Professor of Marketing: Rajesh Bagchi
Virginia-Carolinas Professor of Purchasing Management and Professor of Marketing: Paul M. Herr
Graduate Program Director: Mario Pandelaere
Kathleen Grega Digges Professor in Entrepreneurial Studies: David Brinberg
Robert H. Digges Professor of Entrepreneurial Studies: Dipankar Chakravarti
Mary F. McVay and Theodore R. Rosenberg Junior Faculty Fellow and Prof. of Marketing : Frank May
Professor and Real Estate Fellow: M.J. Sirgy
Associate Professors: E. Coupey, Frank May, and M. Pandelaere
Assistant Professors: S. Goenka, J. Jiang, S. Madan, B. Turner, and Y. Xu
Visiting Assistant Professor: R. Crabbe

Emeritus Faculty: N. Klein, J. E. Littlefield, M. M. Bird, and J. E. Keith
Professor of Practice: B. Collins
Associate Professor of Practice: Donna Wertalik
Advanced Instructor: T. Reilly
Instructor: C. Swayne
Adjunct: J. Hsu
Advising: Pamplin College of Business, Undergraduate Programs Advising Center is located at 1046 Pamplin Hall. Students may schedule appointments by calling (540) 231-6602.

Undergraduate Course Descriptions (MKTG)

MKTG 2104 - Careers in Marketing (1 credit)
Provide students with an early start on understanding the many career options within the marketing major. In-depth focus in developing an online professional branded website and career map. Enhance and broaden the understanding of customer's needs, while gaining the sense of ownership over the product and/or service to meet customer's needs through communication of marketing strategy. Serves as a foundational course in preparing students for career success in the Marketing field. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

MKTG 2954 - Business Study Abroad (1-19 credits)
This course provides students with an international business experience. It is only offered as part of a program outside of the United States. Students will learn from the structured educational experience developed by the faculty leader. This course is intended for students who want to develop marketing-related free electives. Pre: Instructors consent and the completion of 24 semester hours with a minimum GPA of 3.0 or departmental consent.
Instructional Contact Hours: Variable credit course

MKTG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 2964H - Field Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MKTG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 2994 - Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 3104 - Marketing Management (3 credits)
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3104H - Marketing Management (3 credits)
Study of the marketing process from a macro and management viewpoint. The macro viewpoint includes the role of marketing in society. The management viewpoint includes the product, distribution, promotional, and pricing decisions. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3134 - Personal Well-being and Professional Success (3 credits)
In-depth study of the science of well-being and stress management for business and business professionals from multi-disciplinary perspective (Positive Psychology, Consumer Research, Behavioral Economics, Neuroscience, Sociology). Includes relevance of well-being data in marketing and business contexts. Application of well-being and stress management strategies to overcome wellbeing barriers, ensure work-life balance and create positive work environments. Exploration of policy implications of well-being data.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3164 - Introduction to Digital Marketing Strategy (3 credits)
Study of the principles of digital marketing and its applications. Integration of digital strategies with overall business and traditional marketing plans. Emphasis given to critical digital knowledge in inbound marketing, identifying and creating buyer personas, email marketing, search engine optimization, planning and executing digital content marketing calendars, social media marketing, web analytics and digital compliance legislation and regulations, and their ramifications.
Corequisite(s): 3104 or 3104H.
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3504 - Advertising (3 credits)
Survey of advertising principles and its applications. The course covers advertising history, the impact of advertising on society, and ethical and regulatory issues. The process of creating and placing advertising is explored including advertising objectives, budgeting, media planning and mix, creative objectives and strategy, copy execution and production, and copy testing. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4054 - Sales Technology (3 credits)
Course focus is on the integration of technology and data analytics to advance sales. Study of how technology is leveraged in the social sales process which includes how to successfully utilize technology in social selling situations. Emphasis given to Customer Relationship Management (CRM) strategies, benefits, operations, and application across the customer life cycle. Students demonstrate proficiency in CRM technology, through experiential learning by earning Salesforce, Hubspot and Smartfox badges.
Prerequisite(s): MKTG 3104
Corequisite(s): MKTG 4554
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4114 - Introduction to AI in Marketing (3 credits)
Study Artificial Intelligence (AI) and machine learning concepts, myths vs. facts, and barriers associated with AI. Explore the need and uses of AI in marketing and sales. Includes strategies for firms to identify AI opportunities, and the pitfalls and barriers associated with AI implementation. Consider how to implement AI, measure AI success, and gain competitive advantage through AI. Analyze the consumer, firm, and societal impacts of AI from marketing and ethics perspectives, and suggest corrective strategies for firms. Pre: Junior standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4144 - Business and Marketing Strategies for the Process Industries (3 credits)
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4144

MKTG 4154 - Marketing Research (3 credits)
This course is a study of the scientific process of problem solving in a marketing context. It includes concepts of problem definition, hypotheses generation, questionnaire development, research design, implementation, analysis, and interpretation of statistical findings. Junior standing required.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604) and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4164 - Social Media and Content Marketing (3 credits)
Study of social media channels and content creation processes and strategies. Integration of inbound marketing methodologies with social and digital media marketing. Emphasis given to content marketing distribution strategies, influencer marketing, social media advertising, and key content marketing tools including blogs, vlogs, and podcasts, as well as employee advocacy programs and social media and crisis management plans for organizations.
Prerequisite(s): MKTG 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4174 - Analytics & Metrics for Digital Marketing Strategy (3 credits)
Study of the assessment of digital marketing analytics and metrics and their applications. Optimization of digital marketing results across all digital marketing strategies and tactics. Emphasis given to digital marketing measurement models, data-driven decision making including application of the decision-making framework, predictive analytics and data visualizations, website analytics, organic search analytics, social media metrics, email marketing metrics, as well as paid, owned and earned media analytics.
Prerequisite(s): MKTG 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4204 - Consumer Behavior (3 credits)
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4204H - Consumer Behavior (3 credits)
An integrated analysis of individual and environmental influences on consumer decision making, purchase, and consumption behaviors with strong emphasis on implications for developing, executing, and assessing marketing strategy. Junior standing required. Honors section
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4254 - Product and Price Management (3 credits)
Emphasis on strategic branding and product planning within the context of marketing management. Analysis of economic, financial, legal, and marketing principles to make effective pricing decisions. Examination of relationships between product and price management. Junior standing.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4264 - Analytics for Marketing (3 credits)
Integrates conceptual and quantitative aspects of marketing. Provides concentrated emphasis on the role of analytical and computer models to enhance marketing decision making. Emphasis on managerial decision making in key areas, including segmentation and targeting, positioning, forecasting, new product design, forecasting and pricing. Role of consumer perceptions and behaviors on decision making. Hands-on experience with model building and using analytical tools.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4304 - Marketing Communications (3 credits)
Theory and application of an organizations marketing communications function. Includes traditional and digital channels. Development of a marketing communications plan, situation analysis, setting communication goals, creating message strategy, implementing the strategy using promotional mix variables, planning traditional and social media, and determining the communication budget. Junior standing.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4354 - Marketing Channels and Logistics (3 credits)
Management of the firms distribution function. Study of the structure, functions, interactions, and activities of marketing channels. Analysis and development of integrated physical distribution and logistics systems for the firm. Junior standing required.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and (BIT 2405 or (STAT 3005 and STAT 3006) or STAT 3604 or (STAT 3615 and STAT 3616) or STAT 4604) and BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4404 - Field Practicum in Marketing (3 credits)
Application of marketing concepts and theories to a specific business concept. On-site performance of marketing activities and a written analysis of the firms marketing strategy and execution. Junior Standing
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4454 - Sales Force Management (3 credits)
Integration of behavioral research to provide an understanding of the role of the salesperson within the sales organization and in relation to the buyers. Personal selling examines the dyadic interaction between buyer and seller. Managing the sales force covers planning, organizing, directing, and controlling the activities of the sales personnel. Junior standing required.
Prerequisite(s): MKTG 4554 and (MKTG 3104 or MKTG 3104H) and MKTG 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4554 - Principles of Professional Selling (3 credits)
Learn about the management of relationships between buyers and sellers to effectively build partnerships, including the importance of understanding buyer behavior to facilitate the sales process. Explore the concepts of prospecting for customers, planning for the sales call, presentation skills, as well as the formal negotiation process and how these areas relate to adaptive selling. Address common sales management issues including how to manage cross-functional teams and their time and territories, as well as explore the ethical and legal issues that often arise throughout the sales process. Discuss the various career paths and opportunities within sales.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4604 - Retail Management (3 credits)
Analysis of managerial problems in retailing establishments, including traditional and online formats. Focus is on operational problems, retail and e-retail store organization, location analysis, buying, selling, sales promotion, and merchandise handling. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4644 - Marketing, Society and the Public Interest (3 credits)
The impact of marketing on society from a multi- disciplinary and multi-stakeholder perspective. Marketings role in solving societal problems is explored. Topics include at-risk market segments, controversial products and practices, and issues of social justice.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4704 - International Marketing (3 credits)
Assessing international markets, comparing marketing systems; management of international marketing operations; focusing on distribution, promotional, and pricing problems faced by firms engaging in world trade. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4734 - Real Estate Marketing (3 credits)
This course extends the fundamental concepts of marketing into the study and practice of real estate. The course is concerned with the topics of demographic analysis, market information systems, market research, and marketing strategy of residential and commercial real estate, with particular emphasis on the important area of real estate personal selling. Junior standing required.
Prerequisite(s): MKTG 3104 or MKTG 3104H
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4754 - Strategic Marketing (3 credits)
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites--4304, 4354, 4554--may be taken concurrently with 4754.
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4754H - Stategic Marketing (3 credits)
An integrative course in marketing policy and strategy, employing comprehensive case problems in the formulation of marketing action programs and business policy. Senior standing required. Any one of the following Marketing prerequisites - 4304, 4354, 4554 - may be taken concurrently with 4754H
Prerequisite(s): (MKTG 3104 or MKTG 3104H) and MKTG 4154 and (MKTG 4204 or MKTG 4204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4774 - Advanced Professional Selling (3 credits)
Advanced theory and practice of professional selling with primary focus on the professional sales process, analysis of associated strategic and ethical issues, and acquisition of critical skills required of successful salespeople. Builds on foundation created in Buyer/Seller Relationship (MKTG 4554) to expand knowledge and skills of students considering career in professional sales.
Prerequisite(s): MKTG 4554 and MKTG 4204 and (MKTG 3104 or MKTG 3104H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MKTG 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4964H - Field Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MKTG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MKTG 4994H - Honors Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Marketing Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3

MKTG 2104	Careers in Marketing [#]	1
MKTG 4154	Marketing Research [#]	3
MKTG 4204	Consumer Behavior [#]	3
MKTG 4304	Marketing Communications [#]	3
MKTG 4354	Marketing Channels and Logistics [#]	3
MKTG 4554	Principles of Professional Selling [#]	3
MKTG 4644	Marketing, Society and the Public Interest [#]	3
MKTG 4754	Strategic Marketing [#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		37
Marketing Electives [#]		
Select two courses from the MKTG electives list below. [#]		6
Subtotal		6
Elective Credits		
Select remaining credits required for the degree [3]		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [3]		3
Subtotal		46
Total Credits		**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

[2] Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

[3] Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

[#] Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG Electives		
MKTG 3134	Personal Well-being and Professional Success [#]	3
MKTG 3164	Introduction to Digital Marketing Strategy [#]	3
MKTG 3504	Advertising [#]	3
MKTG 4054	Sales Technology [#]	3
MKTG 4114	Introduction to AI in Marketing [#]	3
MKTG 4164	Social Media and Content Marketing [#]	3
MKTG 4254	Product and Price Management [#]	3
MKTG 4264	Analytics for Marketing [#]	3
MKTG 4404	Field Practicum in Marketing [#]	3
MKTG 4454	Sales Force Management [#]	3
MKTG 4604	Retail Management [#]	3
MKTG 4704	International Marketing [#]	3
MKTG 4734	Real Estate Marketing [#]	3
MKTG 4774	Advanced Professional Selling [#]	3
MKTG 4974	Independent Study [#]	3
MKTG 4994	Undergraduate Research [#]	1-19

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding

Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps.

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
	Credits	**18**
Spring Semester		
MKTG 3104	Marketing Management [2, #]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MKTG 2104	Careers in Marketing [#]	1
	Credits	**16**
Third Year		
Fall Semester		
MKTG 4554	Principles of Professional Selling [#]	3
MKTG 4204	Consumer Behavior [#]	3
MKTG 4154	Marketing Research [#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Spring Semester		
MKTG 4304	Marketing Communications [#]	3
MKTG Elective [#]		3
MGT 3404	Principles of Management [2,#]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
MKTG 4644	Marketing, Society and the Public Interest [#]	3
MKTG 4354	Marketing Channels and Logistics [#]	3
MKTG Elective [#]		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Free Elective		3
	Credits	**15**
Spring Semester		
MKTG 4754	Strategic Marketing [#]	3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Electives [3]		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must

complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG Electives		
MKTG 3134	Personal Well-being and Professional Success #	3
MKTG 3164	Introduction to Digital Marketing Strategy #	3
MKTG 3504	Advertising #	3
MKTG 4054	Sales Technology #	3
MKTG 4114	Introduction to AI in Marketing #	3
MKTG 4164	Social Media and Content Marketing #	3
MKTG 4254	Product and Price Management #	3
MKTG 4264	Analytics for Marketing #	3
MKTG 4404	Field Practicum in Marketing #	3
MKTG 4454	Sales Force Management #	3
MKTG 4604	Retail Management #	3
MKTG 4704	International Marketing #	3
MKTG 4734	Real Estate Marketing #	3
MKTG 4774	Advanced Professional Selling #	3
MKTG 4974	Independent Study #	3
MKTG 4994	Undergraduate Research #	1-19

1 **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 **Graduation Requirement**: Students must achieve a **grade of C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business/MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

4 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in- major GPA are noted.

5 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

MKTG Electives

Code	Title	Credits
MKTG 3504	Advertising 1,2	3
MKTG 4254	Product and Price Management 1,2	3
MKTG 4264	Analytics for Marketing 1,2	3
MKTG 4404	Field Practicum in Marketing (by arrangement only) 1,2	3
MKTG 4454	Sales Force Management 1,2	3
MKTG 4604	Retail Management 1,2	3
MKTG 4704	International Marketing 1,2	3
MKTG 4734	Real Estate Marketing 1,2	3
MKTG 4774	Advanced Professional Selling 1,2	3
MKTG 4974	Independent Study (by arrangement only) 2	1-19
MKTG 4994	Undergraduate Research (by arrangement only) 2	1-19

1 **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

2 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

Marketing Management Major with Digital Marketing Strategy Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting 1,2	3
BIT 3414	Operations and Supply Chain Management 2,#	3
HTM 2314	Introduction to International Business 2	3

or MGT 2314	Introduction to International Business	
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
MKTG 2104	Careers in Marketing [#]	1
MKTG 4154	Marketing Research [#]	3
MKTG 4204	Consumer Behavior [#]	3
MKTG 4304	Marketing Communications [#]	3
MKTG 4354	Marketing Channels and Logistics [#]	3
MKTG 4554	Principles of Professional Selling [#]	3
MKTG 4644	Marketing, Society and the Public Interest [#]	3
MKTG 4754	Strategic Marketing [#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		37
Option Required Courses		
MKTG 3164	Introduction to Digital Marketing Strategy [#]	3
MKTG 4164	Social Media and Content Marketing [#]	3
MKTG 4264	Analytics for Marketing [#]	3
MKTG DMS Electives [#]		
Select two courses from the MKTG DMS Elective list. [#]		6
Subtotal		15
Free Elective Credits		
Select remaining credits required for the degree. [3]		6
Subtotal		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [3]		3
Subtotal		46
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG DMS Electives		
ART 4534	Topics in Applied Art and Design Studio [#]	3
ART 4504	Topics in Multimedia Studio [#]	3
BIT 3424	Introduction to Business Analytics Modeling [#]	3
BIT 3434	Advanced Modeling for Business Analytics [#]	3

BIT 3444	Advanced Business Computing and Applications [#]	3
BIT 3514	Systems Analysis [#]	3
BIT 3524	Database Management and Design [#]	3
BIT 3554	Networks, Telecommunications and Security [#]	3
BIT 4444	Web-Based Decision Support Systems [#]	3
BIT 4454	Business Analysis Seminar in IT [#]	3
BIT 4474	Global Operations and Information Technology [#]	3
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries [#]	3
CMST 3064	Persuasion [#]	3
CMST 3124	Interpersonal Communication [#]	3
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics [#]	3
CS/CMDA 3654	Introductory Data Analytics and Visualization [#]	3
CS 3704	Intermediate Software Design and Engineering [#]	3
CS 3714	Mobile Software Development [#]	3
CS 3724	Introduction to Human-Computer Interaction [#]	3
CS/ECE 4570	Wireless Networks and Mobile Systems [#]	3
CS 4604	Introduction to Data Base Management Systems [#]	3
CS 4644	Creative Computing Studio [#]	3
CS 4784	Human-Computer Interaction Capstone [#]	3
ESM 4015 & ESM 4016	Creative Design and Project and Creative Design and Project [#]	6
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
JMC 4264	Social Media Theory and Practice [#]	3
MKTG 3134	Personal Well-being and Professional Success [#]	3
MKTG 4114	Introduction to AI in Marketing [#]	3
MKTG 4254	Product and Price Management [#]	3
MKTG 4404	Field Practicum in Marketing [#]	3
MKTG 4604	Retail Management [#]	3
MKTG 4974	Independent Study [#]	3
MKTG 4994	Undergraduate Research [#]	1-19
SBIO 3124	Paper and Paperboard Packaging [#]	3
SBIO 3445 & SBIO 3446	Entrepreneurial Wood Design and Innovation and Entrepreneurial Wood Design and Innovation [#]	6
SBIO 4024	Packaging Design for Global Distribution [#]	3

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-Requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to Undergraduate Catalog for details.

Roadmap

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
	Credits	**18**
Spring Semester		
MKTG 3104	Marketing Management [2,#]	3
MKTG 3164	Introduction to Digital Marketing Strategy [#]	3

HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MKTG 2104	Careers in Marketing [#]	1
	Credits	**16**
Third Year		
Fall Semester		
MKTG 4554	Principles of Professional Selling [#]	3
MKTG 4204	Consumer Behavior [#]	3
MKTG 4154	Marketing Research [#]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Spring Semester		
MKTG 4304	Marketing Communications [#]	3
MKTG 4164	Social Media and Content Marketing [#]	3
FIN 3104	Introduction to Finance [2,#]	3
MGT 3404	Principles of Management [2,#]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
MKTG 4644	Marketing, Society and the Public Interest [#]	3
MKTG 4354	Marketing Channels and Logistics [#]	3
MKTG DMS Elective [#]		3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
Free Elective		3
	Credits	**15**
Spring Semester		
MKTG 4754	Strategic Marketing [#]	3
MKTG 4264	Analytics for Marketing [#]	3
MKTG DMS Elective [#]		3
MGT 4394	Strategic Management [2,#]	3
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective [3]		3
	Credits	**15**
	Total Credits	**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG DMS Electives		
ART 4534	Topics in Applied Art and Design Studio [#]	3
ART 4504	Topics in Multimedia Studio [#]	3
BIT 3424	Introduction to Business Analytics Modeling [#]	3
BIT 3434	Advanced Modeling for Business Analytics [#]	3
BIT 3444	Advanced Business Computing and Applications [#]	3
BIT 3514	Systems Analysis [#]	3
BIT 3524	Database Management and Design [#]	3
BIT 3554	Networks, Telecommunications and Security [#]	3
BIT 4444	Web-Based Decision Support Systems [#]	3
BIT 4454	Business Analysis Seminar in IT [#]	3
BIT 4474	Global Operations and Information Technology [#]	3
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries [#]	3
CMST 3064	Persuasion [#]	3
CMST 3124	Interpersonal Communication [#]	3
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics [#]	3
CS/CMDA 3654	Introductory Data Analytics and Visualization [#]	3
CS 3704	Intermediate Software Design and Engineering [#]	3
CS 3714	Mobile Software Development [#]	3
CS 3724	Introduction to Human-Computer Interaction [#]	3
CS/ECE 4570	Wireless Networks and Mobile Systems [#]	3
CS 4604	Introduction to Data Base Management Systems [#]	3
CS 4644	Creative Computing Studio [#]	3
CS 4784	Human-Computer Interaction Capstone [#]	3
ESM 4015 & ESM 4016	Creative Design and Project and Creative Design and Project [#]	6
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [#]	3
JMC 4264	Social Media Theory and Practice [#]	3
MKTG 3134	Personal Well-being and Professional Success [#]	3
MKTG 4114	Introduction to AI in Marketing [#]	3
MKTG 4254	Product and Price Management [#]	3
MKTG 4404	Field Practicum in Marketing [#]	3
MKTG 4604	Retail Management [#]	3
MKTG 4974	Independent Study [#]	3
MKTG 4994	Undergraduate Research [#]	1-19

SBIO 3124	Paper and Paperboard Packaging [#]	3
SBIO 3445 & SBIO 3446	Entrepreneurial Wood Design and Innovation and Entrepreneurial Wood Design and Innovation [#]	6
SBIO 4024	Packaging Design for Global Distribution [#]	3

1 **Policy 91**: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 **Graduation Requirement**: Students must achieve a **grade of C- or higher in select business courses** (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business/MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

4 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

5 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

MKTG DMG Electives

Code	Title	Credits
ART 4534	Topics in Applied Art and Design Studio [1,2]	3
ART 4504	Topics in Multimedia Studio [1,2]	3
BIT 3424	Introduction to Business Analytics Modeling [1,2]	3
BIT 3434	Advanced Modeling for Business Analytics [1,2]	3
BIT 3444	Advanced Business Computing and Applications [1,2]	3
BIT 3514	Systems Analysis [1,2]	3
BIT 3524	Database Management and Design [1,2]	3
BIT 3554	Networks, Telecommunications and Security [1,2]	3
BIT 4444	Web-Based Decision Support Systems [1,2]	3
BIT 4454	Business Analysis Seminar in IT [1,2]	3
BIT 4474	Global Operations and Information Technology [1,2]	3
CHE/MKTG 4144	Business and Marketing Strategies for the Process Industries [1,2]	3
CMST 3064	Persuasion [1,2]	3
CMST 3124	Interpersonal Communication [2]	3
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics [1,2]	3
CS/CMDA 3654	Introductory Data Analytics and Visualization [1,2]	3
CS 3704	Intermediate Software Design and Engineering [1,2]	3
CS 3714	Mobile Software Development [1,2]	3
CS 3724	Introduction to Human-Computer Interaction [1,2]	3
CS/ECE 4570	Wireless Networks and Mobile Systems [1,2]	3
CS 4604	Introduction to Data Base Management Systems [1,2]	3
CS 4644	Creative Computing Studio [1,2]	3
CS 4784	Human-Computer Interaction Capstone [1,2]	3
ESM 4015 & ESM 4016	Creative Design and Project and Creative Design and Project [1,2]	6
HTM 4354	Information Technology and Social Media in Hospitality and Tourism [2]	3
JMC 4264	Social Media Theory and Practice [2]	3
MKTG 4254	Product and Price Management [1,2]	3
MKTG 4404	Field Practicum in Marketing (by arrangement only) [1,2]	3
MKTG 4974	Independent Study (by arrangement only) [2]	1-19
MKTG 4994	Undergraduate Research (by arrangement only) [2]	1-19
SBIO 3124	Paper and Paperboard Packaging [1,2]	3
SBIO 3445 & SBIO 3446	Entrepreneurial Wood Design and Innovation and Entrepreneurial Wood Design and Innovation [1,2]	6
SBIO 4024	Packaging Design for Global Distribution [1,2]	3

1 **Pre-requisites:** Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

2 **Overall and In-Major GPA:** Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted.

Marketing Management Major with Professional Sales Option

Code	Title	Credits
Degree Core Requirements		
ACIS 2116	Principles of Accounting [1,2]	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314	Introduction to International Business [2]	3
or MGT 2314	Introduction to International Business	
MGT 4394	Strategic Management [2,#]	3
MKTG 3104	Marketing Management [2,#]	3
Subtotal		21
Major Requirements		

ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
ACIS 2115	Principles of Accounting [1,2]	3
MGT 1104	Foundations of Business [2]	3
MGT 3404	Principles of Management [2,#]	3
MKTG 2104	Careers in Marketing [#]	1
MKTG 4154	Marketing Research [#]	3
MKTG 4204	Consumer Behavior [#]	3
MKTG 4304	Marketing Communications [#]	3
MKTG 4354	Marketing Channels and Logistics [#]	3
MKTG 4554	Principles of Professional Selling [#]	3
MKTG 4644	Marketing, Society and the Public Interest [#]	3
MKTG 4754	Strategic Marketing [#]	3
PSYC 1004	Introductory Psychology	3
or SOC 1004	Introductory Sociology	
Subtotal		37
Option Required Courses		
MKTG 4774	Advanced Professional Selling [#]	3
MKTG 4604	Retail Management [#]	3
MKTG 4454	Sales Force Management [#]	3
MKTG 4054	Sales Technology [#]	3
MKTG PRSL Elective [#]		
Select one course from the MKTG PRSL Electives list [#]		3
Subtotal		15
Free Electives		
Select remaining credits required for the degree		6
Subtotal		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1524	Business Calculus (5F) [1,2]	4
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (5F) [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling (5A) [1,2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Electives [3]		3
Subtotal		46
Total Credits		**125**

1 Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics - ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting - ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling - BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics - ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business, BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG PRSL Electives		
CMST 3064	Persuasion [#]	3
CMST 3124	Interpersonal Communication [#]	3
MKTG 3134	Personal Well-being and Professional Success [#]	3
MKTG 3164	Introduction to Digital Marketing Strategy [#]	3
MKTG 4114	Introduction to AI in Marketing [#]	3
MKTG 4164	Social Media and Content Marketing [#]	3
MKTG 4254	Product and Price Management [#]	3
MKTG 4264	Analytics for Marketing [#]	3
MKTG 4404	Field Practicum in Marketing [#]	3

MKTG 4974	Independent Study #	3
MKTG 4994	Undergraduate Research #	1-19

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution (see footnote 1). Students are responsible for reading and understanding Policy 91 in accordance with Pamplin policies http://pampl.in/policy91 (http://pampl.in/policy91/)

Graduation Requirements

General Information

A total of **125 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

First Year		
Fall Semester		**Credits**
ACIS 1504	Introduction to Business Analytics and Business Intelligence [1,2]	3
MATH 1524	Business Calculus [1,2]	4
MGT 1104	Foundations of Business [2]	3
ENGL 1105 or COMM 1015	First-Year Writing or Communication Skills	3
Select three credits from Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**16**
Spring Semester		
ACIS 2115	Principles of Accounting [1,2]	3
ECON 2005	Principles of Economics [1,2]	3
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
ENGL 1106 or COMM 1016	First-Year Writing or Communication Skills	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
	Credits	**15**
Second Year		
Fall Semester		
ACIS 2116	Principles of Accounting [1,2]	3
ECON 2006	Principles of Economics [1,2]	3
BIT 2406	Introduction to Business Statistics, Analytics, and Modeling [1,2]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Electives		3
	Credits	**18**
Spring Semester		
MKTG 3104	Marketing Management [2,#]	3
FIN 3104	Introduction to Finance [2,#]	3
HTM 2314 or MGT 2314	Introduction to International Business [2] or Introduction to International Business	3
PSYC 1004 or SOC 1004	Introductory Psychology or Introductory Sociology	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
MKTG 2104	Careers in Marketing #	1
	Credits	**16**
Third Year		
Fall Semester		
MKTG 4554	Principles of Professional Selling #	3
MKTG 4204	Consumer Behavior #	3
MKTG 4154	Marketing Research #	3
BIT 3414	Operations and Supply Chain Management [2,#]	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Spring Semester		
MKTG 4304	Marketing Communications #	3
MKTG 4774	Advanced Professional Selling #	3
MKTG 4604	Retail Management #	3
MGT 3404	Principles of Management [2,#]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
	Credits	**15**
Fourth Year		
Fall Semester		
MKTG 4644	Marketing, Society and the Public Interest #	3
MKTG 4354	Marketing Channels and Logistics #	3
MKTG 4454	Sales Force Management #	3
MKTG 4054	Sales Technology #	3
FIN 3054	Legal and Ethical Environment of Business [2,#]	3
	Credits	**15**
Spring Semester		
MKTG 4754	Strategic Marketing #	3
MKTG PRSL Elective #		3
MGT 4394	Strategic Management [2,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Electives [3]		3
Free Electives		3
	Credits	**15**
	Total Credits	**125**

[1] Policy 91: Pamplin students in a business degree program must complete eight business courses (ACIS 1504 Introduction to

Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, and ECON 2005 Principles of Economics-ECON 2006 Principles of Economics) with a grade of C- or higher by 72 attempted credit hours (or 90 attempted credit hours for students with more than 18 transfer credits). Students who have not met the requirements will be notified upon reaching 72 (or 90) credit hours that they must complete the missing course(s) in the next term(s) of enrollment. Failure to do so may result in the student's dismissal from the business degree program. This policy is strictly enforced.

2 Graduation requirement: Students must achieve a grade of C- or higher in select business courses (ACIS 1504 Introduction to Business Analytics and Business Intelligence, MATH 1524 Business Calculus, ACIS 2115 Principles of Accounting-ACIS 2116 Principles of Accounting, BIT 2405 Introduction to Business Statistics, Analytics, and Modeling-BIT 2406 Introduction to Business Statistics, Analytics, and Modeling, ECON 2005 Principles of Economics-ECON 2006 Principles of Economics, MGT 1104 Foundations of Business, HTM 2314 Introduction to International Business or MGT 2314 Introduction to International Business, MGT 3404 Principles of Management, MKTG 3104 Marketing Management, FIN 3104 Introduction to Finance, FIN 3054 Legal and Ethical Environment of Business , BIT 3414 Operations and Supply Chain Management, and MGT 4394 Strategic Management).

3 Critical Analysis of Identity & Equity in the U.S. may be double-counted with another course (major, option, pathway, or free elective) that is designated as pathway 7. If this pathway is already met, students must take a free elective to meet the 125-credit hour requirement.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Code	Title	Credits
MKTG PRSL Electives		
CMST 3064	Persuasion #	3
CMST 3124	Interpersonal Communication #	3
MKTG 3134	Personal Well-being and Professional Success #	3
MKTG 3164	Introduction to Digital Marketing Strategy #	3
MKTG 4114	Introduction to AI in Marketing #	3
MKTG 4164	Social Media and Content Marketing #	3
MKTG 4254	Product and Price Management #	3
MKTG 4264	Analytics for Marketing #	3
MKTG 4404	Field Practicum in Marketing #	3
MKTG 4974	Independent Study #	3
MKTG 4984	Special Study #	3
MKTG 4994	Undergraduate Research #	1-19

Real Estate

Our Website (http://www.realestate.vt.edu)

Overview

The B.S. degree in the Blackwood Program in Real Estate is a comprehensive, interdisciplinary academic program that draws classes from five colleges. The major offers real estate courses that integrate the material students learn in disciplinary courses such as finance, law, and property management through practical experiences within the academic program. The integration occurs though a university-industry partnership where real estate professionals are actively involved in students' education through guest lectures, mentoring experiences, and by providing internship opportunities.

In addition to learning about the broad field of real estate and the entire development process, students are encouraged to find their niche in the field. Students develop an area of expertise by adding a second major, completing a minor, or creating an area of concentration with the approval of their academic advisor. Graduates of the Blackwood Program in Real Estate are prepared to enter the Real Estate industry upon graduation and make immediate professional contributions.

Plan of Study

Note: Graduation requires a total of 120 semester credit hours. Requirements are subject to change; prospective students should contact their academic advisor prior to initiating their programs of study.

Remarks

Restricted Electives - Restricted electives are courses comprised from a focused area of study in the Real Estate profession. This is accomplished by completing a second major or minor. Students are expected to work with a Real Estate Academic Advisor to ensure the completion of restricted electives.

- Real Estate for Commercial Properties Major (p. 760)
- Real Estate for Residential Properties Major (p. 763)

Willis Blackwood Real Estate Director: Kevin J. Boyle
Associate Professor: D. Bieri
Collegiate Assistant Professor: J. Robert
Collegiate Associate Professor, William and Mary Alice Park Junior Faculty Fellow: S. Clements
Assistant Professor of Practice: H. Casey, J. Everett, M. Walsh
Instructor: M. McMahon

Undergraduate Course Descriptions (REAL)

REAL 1004 - Discovering Real Estate (2 credits)
First year experience for the Program in Real Estate. Academic planning, career exploration, and resources for academic success. Leadership, team building, communication and problem solving in the real estate industry. Role of ethics in the profession. Introduction to peer and professional mentors.
Instructional Contact Hours: (2 Lec, 2 Crd)

REAL 1014 - Careers in Real Estate (1 credit)
Provides an overview of multiple facets of the industry and highlights potential real estate careers. Examines academic training and specific skills needed to integrate knowledge from different real estate disciplines Provides an understanding of ethical leadership and pathways to achieve professional success through utilizing professional skills. Pre: First year or sophomore standing.
Corequisite(s): 2004 or UAP 2004.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 1024 - Real Estate: The REAL Deal! (3 credits)
Explore the dynamic world of real estate with a multifaceted understanding of the field. Delve into the history of real estate and compare the fundamentals of real estate across real estate product types. Investigate zoning and design a spatial real estate zoning plan. Differentiate strategies for financial success in real estate, while examining the influence of government on the industry. Engage in discussions that use real estate to solve complex social problems while analyzing issues of identity and equity. Debate diverse outcomes and potential future developments within the ever-evolving landscape of real estate.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2004 - Principles of Real Estate (3 credits)
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2004

REAL 2024 - Principles of Real Estate Sales (1 credit)
Preparation for the Virginia Salesperson License Exam. Residential real estate sales, mortgages and deeds of trust, types of mortgages, liens, real property management, land use controls, deed restrictions, real estate laws, mandated disclosure, property tax and Real Estate Board Regulations. Pass/Fail only.
Prerequisite(s): REAL 2004 or UAP 2004
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 2034 - Real Estate Data Analysis (3 credits)
Overview of statistical analysis for use in the real estate market. Introduction of statistical tools and skills needed to draw conclusions from the data. Understanding data, coding and preparing the data, probability and inference, and special topics in inference including insights to inform ethical management and investment decisions.
Prerequisite(s): (UAP 2004 and REAL 1014) or (UAP 2004 and FIN 2164) or (REAL 2004 and REAL 1014) or (REAL 2004 and FIN 2164) or CEE 2834
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2044 - Professional Development in Real Estate (3 credits)
Professionalism in the real estate industry including professional demeanor, interpersonal and intrapersonal skills, lifelong learning and ethics. Exposure to topics related to personal and professional development such as mentoring, networking, leadership, influencing, negotiating, personal improvement, and utilizing technology in a professional manner.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 1014 or FIN 2164)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 3024 - Applied Real Estate Development (3 credits)
Evaluate zoning and entitlements to understand the feasibility of a real estate development. Recognize the process, stakeholders, and challenges associated with developing diverse types of real estate. Use due diligence research to construct a conceptual site plan. Assess constraints and requirements to select appropriate building design elements. Recognize and implement principles of sustainability in real estate development projects. Describe fundamental principles of the construction phase of development using industry-standard terminology.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3034 - Real Estate Market Analysis (3 credits)
Identification of real estate market areas and reconciling market supply and demand for investments and developments. Applications of market analyses to product types such as residential, retail, office, industrial, hotels and resorts, and mixed-use real estate projects.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3044 - Financing Real Estate Projects (3 credits)
Methods and tools for analyzing financial performance of real estate from initial investment to disposition. Sources and uses of both debt and equity capital. Utilizing proformas to assess risks and feasibility. Budgeting for stabilized properties.
Prerequisite(s): (REAL 2004 or UAP 2004) and (REAL 2034 or BIT 2405) and (ECON 2005 or AAEC 1005)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4024 - Sustainable Real Estate Development (3 credits)
Discuss principles of sustainability related to real estate development. Explore industry recognized sustainable rating systems for buildings and infrastructure. Practice project management strategies for scheduling and cost estimating a successful construction project. Identify key building systems and discuss the process for building renovation and construction. Determine the redevelopment potential of an existing site or building. Relate redevelopment principles to sustainable development. Evaluate the advantages and disadvantages of redevelopment projects based on existing conditions. Recognize the long-term economic, environmental, and social impacts of project decision making.
Prerequisite(s): REAL 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4034 - Real Estate Analytical Methods (1 credit)
Analytical approaches to contemporary topics and issues in real estate decision making. Content varies. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 4044 - Applied Real Estate Investments (3 credits)
Advanced concepts and practices in real estate investing with topics including but not limited to advanced real estate financial modeling, investment risk and return analyses, securitization, sources of funding, portfolio management, and risk management strategies.
Prerequisite(s): REAL 3024 and REAL 3034 and (REAL 3044 or FIN 4154)
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4054 - Real Estate Investment Analysis (1 credit)
Analyze supply and demand to predict and model future real estate cash flows. Evaluate real estate investments using financial ratios and conduct financial risk sensitivity analysis to inform a real estate development decision. Generate formal real estate developmental reports. Participate in external real estate case competitions to further comprehension of a real estate analysis and report drafting. Restricted to REAL majors.
Corequisite(s): 3034 or 3044. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

REAL 4064 - Real Estate Appraisal (3 credits)
Application of economic principles to the valuation and appraisal of property including statistical analysis. Cost approach, sales comparison approach and income capitalization approach to conducting appraisal. Appraisal report for evaluating rural property, commercial, residential and transitional. Ethical and professional requirements. Pre: Senior standing.
Prerequisite(s): REAL 3044 or FIN 4154
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4074 - Residential Real Estate Studio (3 credits)
Course provides mock, real-world learning in a student-led environment. Design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of a residential real estate project. Select a project in consultation with faculty and industry advisors. Work on all elements of the life cycle of a residential real estate project from preliminary design through sale of the developed project.
Prerequisite(s): REAL 3024 and (REAL 3034 or MKTG 4734) and (REAL 3044 or FIN 4154)
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

REAL 4075 - Commercial Real Estate Studio (3 credits)
Couse provides mock, real-world learning in a student-led, team environment. Teams utilize knowledge from prerequisite courses. Teams undertake year-long projects where they design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of complex commercial real estate developments. Teams select projects in consultation with faculty and industry advisors. Work focuses on life cycle of real estate projects from design through sale of development. 4075: topics covered include team building, site/project selection, due diligence, initial site design and market analysis. 4076: topics covered include final site design, financing, construction, leasing and property management, and sale. For majors only, senior standing. Design/Lab Studio.
Prerequisite(s): REAL 3024 and REAL 3034
Instructional Contact Hours: (1 Lec, 2 Lab, 3 Crd)

REAL 4076 - Commercial Real Estate Studio (3 credits)
Couse provides mock, real-world learning in a student-led, team environment. Teams utilize knowledge from prerequisite courses. Teams undertake year-long projects where they design, analyze site and financial feasibility, formulate construction plans, and execute leasing and sale of complex commercial real estate developments. Teams select projects in consultation with faculty and industry advisors. Work focuses on life cycle of real estate projects from design through sale of development. 4075: topics covered include team building, site/project selection, due diligence, initial site design and market analysis. 4076: topics covered include final site design, financing, construction, leasing and property management, and sale. For majors only, senior standing. Design/Lab Studio.
Prerequisite(s): (REAL 3044 or FIN 4154) and REAL 4075
Instructional Contact Hours: (1 Lec, 2 Lab, 3 Crd)

REAL 4754 - Real Estate Law (3 credits)
Fundamentals of law as it applies to real estate ownership. Rules, rights, and duties of owners of real estate. Elements of contract law and legal documents, including acquisition and disposal of property, leases, and agreements with third-party service providers. Implications for real estate taxation. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

REAL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

REAL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Real Estate for Commercial Properties Major

Code	Title	Credits
Degree Core Requirements		
REAL 1004	Discovering Real Estate [#]	2
REAL 1014	Careers in Real Estate [#]	1
REAL/UAP 2004	Principles of Real Estate [#]	3
ACIS 2115	Principles of Accounting	3
REAL 2044	Professional Development in Real Estate [#]	3
REAL 3024	Applied Real Estate Development [1,#]	3
REAL 3044	Financing Real Estate Projects [1,#]	3
REAL 4754	Real Estate Law [#]	3
Subtotal		21
Major Requirements		
COMM 2004	Public Speaking [2,#]	3
REAL 2034	Real Estate Data Analysis [3,#]	3
REAL 3034	Real Estate Market Analysis [1,#]	3
ENGL 3764	Technical Writing [#]	3
PM 4684	Leasing Commercial Properties [#]	3
REAL 4075	Commercial Real Estate Studio [1,4,#]	3
REAL 4076	Commercial Real Estate Studio [4,#]	3
Select one of the following: [#]		3
BC 2014	Construction Principles I [#]	
GEOG 2084	Principles of Geographic Information Systems [#]	
HIST 2494	Cities in History [#]	
MGT 2354	Teams, Leadership, and Business: Cultivating Excellence [#]	
PM 3684	Sustainable Property Management [#]	
PM 4644	Advanced Property and Asset Management [#]	
REAL 3954	Study Abroad (must be 3 credits) [#]	
REAL 4064	Real Estate Appraisal [#]	
SPIA 4454	Future of Cities [#]	
Subtotal		24
Restricted Electives [6]		
Complete 21 credit hours, at least 50% at the 3000 or 4000 level - see footnote 6. [6]		21
Subtotal		21
Free Electives		
Select remaining credit hours required to fulfill degree requirements.		14

Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015 & COMM 1016	Communication Skills and Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	6
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with ENGL 3764 [#]		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credit hours of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) with 3 credit hours double counting with Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credit hours of Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Three credit hours of Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) fulfilled with REAL 2034 [3,#]		
MATH 1524	Business Calculus (recommended for Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
SPIA 2004	Introduction to Urban Analytics (recommended for Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credit hours of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
MGT 2064	Foundations of Entrepreneurship (recommended for Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective if course is taken to double count for Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) and Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		3
Subtotal		40
Total Credits		**120**

1. Graduation requirement: Students must achieve a grade of C- or higher in REAL 3024 Applied Real Estate Development, REAL 3034 Real Estate Market Analysis, REAL 3044 Financing Real Estate Projects, and REAL 4075 Commercial Real Estate Studio.
2. COMM 2004 Public Speaking is only required if students do not take COMM 1015 Communication Skills and COMM 1016 Communication Skills for Pathways Concept 1F.
3. BIT 2405 Introduction to Business Statistics, Analytics, and Modeling substitutes for REAL 2034 Real Estate Data Analysis.
4. REAL 4075 Commercial Real Estate Studio and REAL 4076 Commercial Real Estate Studio must be taken in sequence; Fall/Spring of the same academic year or Spring/Fall of the same calendar year.
5. Concept 7 must be satisfied if a course is not selected that double counts for Concepts 2 and 7.
6. Students must have a restricted elective plan of study approved by their real estate advisor by fall of their third year. It must consist of a declared double major or minor related to a focused area of study related to commercial real estate. Students who are double majors may substitute courses from their other major for restricted electives if the courses are not real estate requirements in the BS Real Estate Degree Core Requirements or Real Estate for Commercial Properties Major Requirements.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution. Students in the real estate degree program with 30 or more credit hours must enroll in at least one REAL course per semester. Failure to do so may result in the student's dismissal from the real estate degree program. This policy is strictly enforced.

Graduation Requirements

General Information

A total of **120 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/).

Overall and In-Major GPA

Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credit hours required for graduation. Please refer to the Undergraduate Catalog for details.

First Year

Fall Semester		**Credits**
REAL 1004	Discovering Real Estate [#]	2
REAL/UAP 2004	Principles of Real Estate [#]	3
COMM 1015	Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [5]		3
MATH 1524	Business Calculus (recommended for Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
	Credits	**15**
Spring Semester		
REAL 1014	Careers in Real Estate [#]	1
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
COMM 1016	Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
	Credits	**16**

Second Year

Fall Semester		
REAL 2034	Real Estate Data Analysis [3,#]	3
ACIS 2115	Principles of Accounting	3
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [5]		3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Spring Semester		
REAL 2044	Professional Development in Real Estate [#]	3
COMM 2004	Public Speaking [2,#]	3
SPIA 2004	Introduction to Urban Analytics (recommended for Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
MGT 2064	Foundations of Entrepreneurship (recommended for Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	3
Free Elective		3
	Credits	**15**

Third Year

Fall Semester		
REAL 3024	Applied Real Estate Development [1,#]	3
ENGL 3764	Technical Writing [#]	3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3
Free Elective		3
	Credits	**15**
Spring Semester		
REAL 3034	Real Estate Market Analysis [1,#]	3
PM 4684	Leasing Commercial Properties [#]	3
RELC Major Requirement [#]		3
RE Restricted Elective [6]		3
Free Elective		3
	Credits	**15**

Fourth Year

Fall Semester		
REAL 3044	Financing Real Estate Projects [1,#]	3
REAL 4075	Commercial Real Estate Studio [1,4,#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3
	Credits	**15**
Spring Semester		
REAL 4076	Commercial Real Estate Studio [4,#]	3
REAL 4754	Real Estate Law [#]	3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3
Free Elective (remaining credits left for degree)		2
	Credits	**14**
	Total Credits	**120**

RE Major Requirement

Code	**Title**	**Credits**
Choose one		
BC 2014	Construction Principles I [#]	3
GEOG 2084	Principles of Geographic Information Systems [#]	3
HIST 2494	Cities in History [#]	3
MGT 2354	Teams, Leadership, and Business: Cultivating Excellence [#]	3
PM 3684	Sustainable Property Management [#]	3
PM 4644	Advanced Property and Asset Management [#]	3
REAL 3954	Study Abroad [#]	3
REAL 4064	Real Estate Appraisal [#]	3
SPIA 4454	Future of Cities [#]	3

1 Graduation requirement: Students must achieve a grade of C- or higher in REAL 3024 Applied Real Estate Development, REAL 3034 Real Estate Market Analysis, REAL 3044 Financing Real Estate Projects, and REAL 4075 Commercial Real Estate Studio.

2 COMM 2004 Public Speaking is only required if students do not take COMM 1015 Communication Skills and COMM 1016 Communication Skills for Pathways Concept 1F.

3 BIT 2405 Introduction to Business Statistics, Analytics, and Modeling substitutes for REAL 2034 Real Estate Data Analysis.

4 REAL 4075 Commercial Real Estate Studio and REAL 4076 Commercial Real Estate Studio must be taken in sequence; Fall/Spring of the same academic year or Spring/Fall of the same calendar year.

5 Concept 7 must be satisfied if a course is not selected that double counts for Concepts 2 and 7.

6 Students must have a restricted elective plan of study approved by their real estate advisor by fall of their third year. It must consist of a declared double major or minor related to a focused area of study related to commercial real estate. Students who are double majors may substitute courses from their other major for restricted electives if the courses are not real estate requirements in the BS Real Estate Degree Core Requirements or Real Estate for Commercial Properties Major Requirements.

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Real Estate for Residential Properties Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
REAL 1004	Discovering Real Estate [#]	2
REAL 1014	Careers in Real Estate [#]	1
REAL/UAP 2004	Principles of Real Estate [#]	3
ACIS 2115	Principles of Accounting	3
REAL 2044	Professional Development in Real Estate [#]	3
REAL 3024	Applied Real Estate Development [1,#]	3
REAL 3044	Financing Real Estate Projects [1,#]	3
REAL 4754	Real Estate Law [#]	3
Subtotal		21
Major Requirements		
COMM 2004	Public Speaking [2,#]	3
PM 2664	Introduction to Property Management [#]	3
ENGL 3764	Technical Writing [#]	3
REAL 2034	Real Estate Data Analysis [#]	3
REAL 4064	Real Estate Appraisal [3,#]	3
REAL 4074	Residential Real Estate Studio [1,3,#]	3
MKTG 4734	Real Estate Marketing [1,#]	3
Select one of the following: [#]		3
AAEC 2104	Personal Financial Planning [4,#]	
or CONS 2304	Consumer and Family Finances	
BC 2014	Construction Principles I [#]	
HIST 2494	Cities in History [#]	
MGT 2064	Foundations of Entrepreneurship [#]	
PM 3684	Sustainable Property Management [#]	
REAL 3954	Study Abroad (must be 3 credits) [#]	
SPIA 4454	Future of Cities [#]	
UAP 3014	Urban Policy and Planning [#]	
Subtotal		24
Restricted Electives [6]		
Complete 18-21 credit hours, at least 50% at the 3000 or 4000 level. See footnote 6 - students must choose one of the listed minors by the start of the fall of their third year. [6]		21
Subtotal		21
Free Electives		
Select remaining credit hours required to fulfill degree requirements.		14
Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015 & COMM 1016	Communication Skills and Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	6
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with ENGL 3764		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credit hours of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) with 3 credit hours double counting with Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credit hours of Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Three credit hours of Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) fulfilled with REAL 2034 [#]		
MATH 1524	Business Calculus (recommended for Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
AAEC 2104	Personal Financial Planning (recommended for Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)) [4,#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credit hours of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
MGT 2064	Foundations of Entrepreneurship (recommended for Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)) [#]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective if course is taken to double count for Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) and Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		3
Subtotal		40
Total Credits		**120**

1. Graduation requirement: Students must achieve a grade of C- or higher in MKTG 4734 Real Estate Marketing, REAL 3024 Applied Real Estate Development, REAL 3044 Financing Real Estate Projects, and REAL 4074 Residential Real Estate Studio.
2. COMM 2004 Public Speaking is only required if students do not take COMM 1015 Communication Skills and COMM 1016 Communication Skills for Pathways Concept 1f.
3. Offered Spring semester only. Students graduating in the Fall semester must plan to enroll in the Spring prior.
4. Students cannot take both AAEC 2104 Personal Financial Planning and CONS 2304 Consumer and Family Finances for credit.
5. Concept 7 must be satisfied if a course is not selected that double counts for Concepts 2 and 7.
6. Students must choose one of the following minors by the start of the fall of their third year.

- Entrepreneurship – New Venture Growth (ENVG) (18 Credits)
- Housing and Society (Data Analysis Track or Sustainability Track (HOSO) (18 c redits)
- Professional Sales (PRFS) (21 credits)
- Property Management (PM) (18 credits)
- Residential Environments (RENV) (18-19 credits)
- Smart and Sustainable Cities (SSC) (18 credits)

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Policy 91

University policy requires a student to make satisfactory academic progress towards a degree in order to remain enrolled at the institution. Students in the real estate degree program with 30 or more credits must enroll in at least one REAL course per semester. Failure to do so may result in the student's dismissal from the real estate degree program. This policy is strictly enforced.

Graduation Requirements

General Information

A total of **120 credit hours** is required for graduation. Any exceptions to this curriculum must be approved by the student's department head and Associate Dean for Pamplin Undergraduate Programs.

Pre-requisites

Students are responsible for ensuring they have met the necessary pre-requisites for all courses. Please refer to the Undergraduate Catalog or academic advisor.

Transferring Courses

Requirements and procedures for transferring courses are available http://pampl.in/transfercreditsteps (http://pampl.in/transfercreditsteps/)

Overall and In-Major GPA:

Students must have an overall GPA of 2.00 and an in-major GPA of 2.00 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement may not count towards the minimum credits required for graduation. Please refer to the Undergraduate Catalog for details.

First Year		
Fall Semester		**Credits**
REAL 1004	Discovering Real Estate [#]	2
REAL/UAP 2004	Principles of Real Estate [#]	3
COMM 1015	Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [5]		3
MATH 1524	Business Calculus (recommended for Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	4
	Credits	**15**
Spring Semester		
REAL 1014	Careers in Real Estate [#]	1
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
COMM 1016	Communication Skills (recommended for Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) [2]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Free Elective		3
	Credits	**16**
Second Year		
Fall Semester		
REAL 2034	Real Estate Data Analysis [#]	3
ACIS 2115	Principles of Accounting	3
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
PM 2664	Introduction to Property Management [#]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [5]		3
	Credits	**15**
Spring Semester		
REAL 2044	Professional Development in Real Estate [#]	3
COMM 2004	Public Speaking [2,#]	3
AAEC 2104	Personal Financial Planning (recommended for Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)) [4,#]	3
MGT 2064	Foundations of Entrepreneurship (recommended for Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)) [#]	3
Select three credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
	Credits	**15**
Third Year		
Fall Semester		
REAL 3024	Applied Real Estate Development [1,#]	3
ENGL 3764	Technical Writing [#]	3
RELR Major Requirement [#]		3
RE Restricted Elective [6]		3
Free Elective		3
	Credits	**15**
Spring Semester		
REAL 3044	Financing Real Estate Projects [1,#]	3
MKTG 4734	Real Estate Marketing [1,#]	3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3
Free Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
REAL 4754	Real Estate Law [#]	3
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) or Free Elective if course is taken to double count for Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) and Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [5]		3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3

Free Elective		3
	Credits	**15**
Spring Semester		
REAL 4074	Residential Real Estate Studio [1,3,#]	3
REAL 4064	Real Estate Appraisal [3,#]	3
RE Restricted Elective [6]		3
RE Restricted Elective [6]		3
Free Elective (remaining credits required for degree)		2
	Credits	**14**
	Total Credits	**120**

RELR Major Requirement

Code	Title	Credits
Choose one		
AAEC 2104	Personal Financial Planning [4,#]	3
or CONS 2304	Consumer and Family Finances	
BC 2014	Construction Principles I [#]	3
HIST 2494	Cities in History [#]	3
MGT 2064	Foundations of Entrepreneurship [#]	3
PM 3684	Sustainable Property Management [#]	3
REAL 3954	Study Abroad [#]	3
SPIA 4454	Future of Cities [#]	3
UAP 3014	Urban Policy and Planning [#]	3

1 Graduation requirement: Students must achieve a grade of C- or higher in MKTG 4734 Real Estate Marketing, REAL 3024 Applied Real Estate Development, REAL 3044 Financing Real Estate Projects, and REAL 4074 Residential Real Estate Studio.

2 COMM 2004 Public Speaking is only required if students do not take COMM 1015 Communication Skills and COMM 1016 Communication Skills for Pathways Concept 1f.

3 Offered Spring semester only. Students graduating in the Fall semester must plan to enroll in the Spring prior.

4 Students cannot take both AAEC 2104 Personal Financial Planning and CONS 2304 Consumer and Family Finances for credit.

5 Concept 7 must be satisfied if a course is not selected that double counts for Concepts 2 and 7.

6 Students must choose one of the following minors by the start of the fall of their third year

- Entrepreneurship – New Venture Growth (ENVG) (18 Credits)
- Housing and Society (Data Analysis Track or Sustainability Track (HOSO) (18 c redits)
- Professional Sales (PRFS) (21 credits)
- Property Management (PM) (18 credits)
- Residential Environments (RENV) (18-19 credits)
- Smart and Sustainable Cities (SSC) (18 credits)

Overall and In-Major GPA: Students must have an overall GPA of 2.0 and an in-major GPA of 2.0 to graduate. Courses used to calculate the in-major GPA are noted with a # footnote.

College of Engineering

Our Website (http://www.eng.vt.edu)

Mission, Vision, and Values

Mission: Anchored by our land-grant identity and the university's motto Ut Prosim (That I May Serve), the College of Engineering educates and inspires students to be critical thinkers, innovators, and leaders. We create new knowledge, technologies, and sustainable solutions that address complex social and technical challenges.

Vision: The Virginia Tech College of Engineering will be the college of choice for aspiring engineers because of our innovative, dynamic, and integrated approach to education, research, and service. Our students and alumni will be sought globally for their talent, creativity, and work ethic. The impact of our transdisciplinary research will advance the boundaries of engineering knowledge and practice. Our solutions will make a difference in the Commonwealth and the world.

The Mission and Vision are informed by five Core Values:

- Inclusiveness: Our community supports equity and fosters respect for every individual, enabling collaboration and collegiality to permeate our classrooms, research facilities, and offices, and to extend to the broader university community. We recognize the importance of allowing every voice to be heard in a spirit of mutual respect.
- Excellence: We are committed to excellence through continuous improvement in our teaching, research, service and day-to-day operations.
- Integrity: Ethics, honesty and transparency are the foundation of all that we do. We believe in honor, discipline and a commitment to do the right thing.
- Perseverance: We are tenacious and believe in the value of hard work. Through resilience, teamwork and a supportive community, we become stronger and more agile, enabling us to adapt to future challenges and opportunities.
- Stewardship: As citizens, innovators, and leaders, we serve our communities, both local and global. We seek to be environmental stewards, believing that engineering for sustainability is critical for the future health of our world and its inhabitants.

College of Engineering at-a-Glance

Virginia Tech engineering students are among the best and brightest in the nation. During their time at the college, they engage with world-class faculty and participate in hands-on learning experiences that span course instruction, student design teams, internship opportunities, and study abroad programs. They learn to work across and outside disciplines to solve the world's most complex problems, as part of a collaborative culture that has flourished at Virginia Tech.

The College of Engineering offers accredited programs leading to Bachelor of Science degrees in the following areas:

- **Aerospace Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Aerospace and Similarly Named Engineering Programs.
- **Biological Systems Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Biological and Similarly Named Engineering Programs.
- **Biomedical Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Bioengineering and Biomedical and Similarly Named Engineering Programs.

- **Building Construction** which is accredited by the American Council for Construction Education, https://www.acce-hq.org (http://www.acee-hq.org/).
- **Chemical Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Chemical, Biochemical, Biomolecular and Similarly Named Engineering Programs.
- **Civil Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Civil and Similarly Named Engineering Programs.
- **Computer Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs.
- **Construction Engineering and Management** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Construction and Similarly Named Engineering Programs and is also accredited by the Applied and Natural Science Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Construction and Similarly Named Engineering Programs.
- **Computer Science** which is accredited by the Computing Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Computer Science and Similarly Named Engineering Programs.
- **Electrical Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs.
- **Industrial and Systems Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Industrial and Similarly Named Engineering Programs.
- **Materials Science and Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Materials, Metallurgical, Ceramics and Similarly Named Engineering Programs.
- **Mechanical Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Mechanical and Similarly Named Engineering Programs.
- **Mining Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Mining and Similarly Named Engineering Programs.
- **Ocean Engineering** which is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Ocean and Similarly Named Engineering Programs.

Experiential Learning

The Virginia Tech College of Engineering fosters opportunities for hands-on learning, interdisciplinary collaboration, and exploration of emerging and innovative subject areas.

The Ware Lab is one of the first spaces on Virginia Tech's campus dedicated to the development of an undergraduate engineering build space. Prior to the founding of the Ware Lab, the university's design teams meet in multiple spaces spread across campus in various academic buildings. Thanks to the generosity and vision of Ware, multidisciplinary teams can interact in a common space. The lab removes boundaries that often separate engineering professions. In real-world practice, engineers from different disciplines will work together. Students who work in the lab are highly recruited by top-tier companies who frequent the lab looking for the well-rounded, globally minded engineers who have had hands on experiences. Further information can be found: https://eng.vt.edu/academics/warelab.html.

The Advanced Engineering Design Lab (AEDL) provides additional space for engineering teams that focus on aerospace and rocketry projects. Further information can be found: https://eng.vt.edu/academics/aerospace-engineering-design-lab.html.

Students can participate in Undergraduate Research and Independent Research. Undergraduate Research offers students the opportunity to work closely with a faculty member in a research lab environment or performing directed work toward a research goal. Undergraduate Research can serve as valuable preparation for graduate study. Independent Study provides students an opportunity to pursue unique, self-directed study under the supervision of a faculty member. Further information can be found at: https://eng.vt.edu/academics/undergraduate-students/resources-support/undergraduate-research-independent-study.html

The College of Engineering has several options for students to have a global experience. Some notable opportunities include the Rising Sophomore Abroad Program (RSAP) which provides a 2-week abroad along with a 3-credit course (ENGE 1644); international internship experiences with SPTS International, Rolls-Royce, and GoinGlobal; and department specific study abroad programs that allow students to continue progress toward degree while taking courses at a non-U.S. university. Additional information can be found at: https://eng.vt.edu/academics/international-programs.html.

Approximately 75% of college of engineering students participate in a co-op or internship allowing them to experience professional work prior to completing their degree. One of the primary ways that students find these opportunities is the Engineering EXPO, a career fair organized by the Student Engineering Council (SEC) that is typically held early in the Fall semester each year. Engineering EXPO is one of the largest student-run career fairs in the nation and hosts hundreds of companies offering full-time employment or internship and co-op opportunities. Additional information on Engineering EXPO can be found at: https://www.sec.vt.edu/expo.html.

Many undergraduate engineering programs culminate in a capstone senior design course sequence in which student teams work under the supervision of a faculty advisor to complete a client-driven design project. Such projects replicate aspects of professional problem-solving experience, providing a transitional learning experience to help

students prepare for a professional career. The college also offers an Interdisciplinary Capstone Course (ENGE 4735-4736) that brings together students from different majors to work on design projects that require multiple fields of expertise.

Undergraduate Scholarships

In the 2022-2023 academic year, over three million dollars in scholarship funds were awarded to undergraduate students in the College of Engineering. Scholarships are available at two levels: departmental & college. The scholarship opportunities are varied. Some require a minimum GPA for eligibility while others require a demonstration of financial need per the FAFSA. Some others have specific eligibility criteria such as in-state residency, participation in the Corps of Cadets, etc., however, the College of Engineering uses a single application process for all scholarships. More information about the types of scholarships awarded can be found at https://eng.vt.edu/academics/undergraduate-students/resources-support/scholarships-financial/scholarships-for-current-students.html.

Admission to Major

All students admitted to the College of Engineering as First Time in College (FTIC) students with an intent to pursue an engineering or computer science major are placed in the Department of Engineering Education and are designated as General Engineering majors. General Engineering provides an innovative learning environment that embraces a hands-on, minds-on approach, which leverages the latest advances in educational technologies to fully engage students in the learning experience. The first-year course sequence integrates professional and technical skills to give students tools for tackling the grand challenges of the 21st century. The program introduces students to the wide range of engineering majors in the College of Engineering so that students are able to make informed decisions about their educational pathways. Further information on General Engineering can be found in the overview (https://catalog.vt.edu/undergraduate/college-engineering/engineering-education/#text) for the Department of Engineering Education in the undergraduate catalog.

While in the General Engineering program, students will complete the courses required to matriculate to a degree-granting engineering or computer science program. Further information on the process to enter a degree-granting engineering or computer science program is available at: https://eng.vt.edu/academics/undergraduate-students/resources-support/change-of-major/restricted.html.

Students admitted to the College of Engineering as FTIC students with an intent to pursue the Building Construction major are directly admitted to that major.

All students admitted to the College of Engineering as transfer students will be directly admitted to the major indicated on their application. Transfer applications are competitive and prospective transfer students are strongly encouraged to consult the Admissions Transfer Roadmaps posted by the university to prepare themselves for success in their intended major. (https://vt.edu/admissions/transfer/roadmaps.html)

Students wishing to transfer into an engineering major or change majors from another college or degree program within the university must meet current standards set by the college for each engineering program. All major changes are processed by the Director of Enrollment Management in the Academic Affairs office.

The college has a guaranteed admission agreement with the Virginia Community College System. VCCS students who complete the transferable Associate Degree in engineering with a minimum 3.2 overall grade-point-average are guaranteed admission to the College of Engineering. Not all Virginia Community Colleges offer engineering courses. Please review Guaranteed Admission Agreement (posted at https://www.vt.edu/admissions/transfer/vccs.html) for specific information on this agreement.

Engineering Technology credits are not accepted for transfer by the College of Engineering.

Required Academic Progress and Graduation Requirements

The University requires a student to maintain a 2.0 or higher overall GPA to remain in Good Academic Standing.

Additionally, departments have minimum requirements for graduation, which include the attainment of at least a 2.0 Grade Point Average (averaging "C" grades or better), both overall and in-major. Some departments may have additional requirements or specifications concerning the acceptability of C- or lower grades for in-major courses. Students are expected to sustain progress towards completion of their degree requirements, consulting with their academic advisor regularly.

Failure to meet the criteria for satisfactory progress towards degree (University Policy 91) can result in suspension from the major. Individual departments establish the criteria for their majors which are listed for each program in the undergraduate catalog.

Although pass/fail courses may be authorized for those who maintain a GPA above 2.0, students should recognize future disadvantages when transferring to other departments or applying for admission to other professional or graduate colleges. Engineering students are expected to take all major department courses on a grade basis.

The College of Engineering will accept advanced ROTC credit as free elective credit towards graduation. Some departments in engineering may allow the use of selected ROTC courses to meet technical elective requirements. Consult specific departments in the College of Engineering for information.

Additional academic policies may apply. Students should also be aware of the requirements listed in the Academic Policies section of the undergraduate catalog.

Degree Requirements

The graduation requirements in effect during the academic year of admission to Virginia Tech apply. Requirements for graduation are listed in the undergraduate catalog. Students must satisfactorily complete all requirements and university obligations for degree completion. The university reserves the right to modify requirements in a degree program.

- Aerospace Engineering Major (p. 777)
- Applied Electromagnetics Major (p. 855)
- Automotive Engineering Major (p. 923)
- Biological Systems Engineering Major (p. 791)
- Biomedical Engineering Major (p. 798)
- Building Construction Major (p. 805)
- Chemical Engineering Major (p. 812)
- Chip-Scale Integration Major (p. 858)

- Civil Engineering Major (p. 822)
- Computer Engineering Major (p. 861)
- Computer Science Major (p. 833)
- Construction Engineering and Management Major (p. 951)
- Construction Safety Leadership Major (https://catalog.vt.edu/undergraduate/college-engineering/construction-engineering-management/construction-safety-leadership-bs/)
- Controls, Robotics & Autonomy Major (p. 866)
- Controls, Robotics & Autonomy Major (p. 864)
- Data-Centric Computing Major (p. 837)
- Ecological Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/biological-systems-engineering/ecological-engineering/)
- Electrical Engineering Major (p. 869)
- Energy & Power Electronic Systems Major (p. 872)
- Environmental Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/civil-environmental-engineering/environmental-engineering-bs/)
- Industrial and Systems Engineering Major (p. 896)
- Machine Learning Major (p. 874)
- Materials Science and Engineering Major (p. 905)
- Materials Science and Engineering Major with Nuclear Materials Option (p. 908)
- Mechanical Engineering Major (p. 925)
- Micro/Nanosystems Major (p. 877)
- Mining Engineering Major (p. 937)
- Networking & Cybersecurity Major (p. 880)
- Ocean Engineering Major (p. 783)
- Robotics and Mechatronics Major (p. 931)
- Secure Computing Major (p. 841)
- Software Systems Major (p. 882)
- Wireless Communications and Signal Processing Major (p. 885)

Dean: Julia Ross
Associate Dean for Academic Affairs: Keith Thompson
Associate Dean for Administration and Chief of Staff: Edward L. Nelson
Associate Dean for Information Technology: Glenda R. Scales
Associate Dean for Graduate and Professional Studies: Holly Matusovich
Assistant Dean Advancement: Jeremy Weaver

Engineering – Non Major Specific Courses

Overview

The following courses are applicable to study in several departments and do not carry departmental designations. Several of the undergraduate courses listed below were developed specifically for students in both engineering and non-engineering majors with the objective of broadening the base of knowledge in cross-disciplinary areas with some background within a technology driven focus. Some of these courses were created for students living in the College of Engineering's Living Learning Communities of Hypatia and Galileo, and are restricted to those students. Others were created as part of the academic, professional and personal support services provided for engineering students. Most students will use these courses to satisfy free electives in their programs. Engineering students also may find these courses of value in broadening their perspectives regarding their fields of study and may wish to use them as free electives in their programs.

Undergraduate Course Descriptions (ENGR)

ENGR 1014 - Engineering Research Seminar (1 credit)
Discussion of current research topics in the College of Engineering by Virginia Tech Faculty. (1C, 1H)
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 1034 - First Year Hypatia Seminar (2 credits)
Success strategies that are designed for first-year female engineering students who are residents of the Hypatia learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineerings departments/majors.
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 1054 - First Year Galileo Seminar (2 credits)
Success strategies that are designed for first-year male engineering students who are residents of the Galileo learning community are presented. Students are provided information on study skills; resources and academic support for Virginia Tech students; gender issues in engineering; service learning; leadership; technology; and the College of Engineerings department/majors. (2H, 2C)
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2004A - Engineering International Activity (0 credits)
Engineering International Education course reflects academic effort in study abroad settings as defined by the college. No degree applicable credit awarded. Enrollment in this course does not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2004E - Engineering Experiential Learning (0 credits)
Engineering Experiential course reflects college defined experiential learning experiences for undergraduates. No degree applicable credit is awarded. Enrollment in this course does not apply toward the definition of full time status.
Instructional Contact Hours: (0 Crd)

ENGR 2004R - Engineering Undergraduate Exploratory Activity (0 credits)
Engineering Undergraduate Exploratory Activity course is an undergraduate research experience as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2004S - Engineering Service Learning (0 credits)
Engineering Service Learning course reflects academic effort in service learning settings as defined by the college. No degree applicable credit is awarded. Enrollment in this course will not apply toward the definition of full time status. 0 Credits.
Instructional Contact Hours: (0 Crd)

ENGR 2044 - Second-Year Galileo and Hypatia Seminar (1 credit)
Second-Year Galileo and Hypatia seminar for student leaders. Success strategies designed for second-year engineering students who are participants of the Galileo and Hypatia Living-Learning Community; topics include communication skills, critical thinking skills, diversity, leadership, networking with peers and future employers, and goals associated with academic and professional success.
Prerequisite(s): ENGR 1034 or ENGR 1054
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 2164 - Introduction to Scieneering (1 credit)
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction interdisciplinary thinking and communication; issues related to interdisciplinary research teams.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: COS 2164

ENGR 2464 - Engineering Fundamentals for Scientists (2 credits)
Introduction to the engineering profession and basic engineering skills for students pursuing science majors. Fundamentals of graphing, technical communication, ethics, the design process, project management, and problem solving as applicable to engineering. Partially duplicates ENGE 1024. May not be used for credit towards any degree from the College of Engineering.
Prerequisite(s): ENGR 2164 or COS 2164
Instructional Contact Hours: (2 Lec, 2 Crd)

ENGR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

ENGR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 3044 - Third-Year Galileo and Hypatia Seminar (1 credit)
Success strategies designed for third year engineering students who are participants of the Galileo and Hypatia Living-Learning Community; topics include critical thinking skills, diversity, leadership, networking with peers and future employers, and goals associated with academic and professional success.
Prerequisite(s): ENGR 2044
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGR 3124 - Introduction to Green Engineering (3 credits)
Introduction to green engineering and global environmental issues. Impacts of human and engineering activities on the environment, and techniques that can be utilized to minimize adverse environmental impacts with emphasis on environmentally conscious design and manufacturing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4064 - Scieneering Capstone (3 credits)
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor.
Prerequisite(s): ENGR 2464 or BIOL 2124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: COS 4064

ENGR 4134 - Environmental Life Cycle Assessment (3 credits)
Quantification of the environmental impacts for products, processes, and systems across all engineering disciplines. A detailed look at life cycle phases and formal and informal Life Cycle Assessment (LCA) methodologies including ISO standards, stream-lined LCA, green building ratings systems, carbon footprints, and other environmental ratings systems.
Prerequisite(s): ENGR 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGR 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Aerospace and Ocean Engineering

Our Website (http://www.aoe.vt.edu)

Overview

The Kevin T. Crofton Department of Aerospace and Ocean Engineering offers a Bachelor of Science degree in aerospace and ocean engineering. Students may major in either aerospace engineering or ocean engineering. These majors share many course requirements, because the two curricula cover a broad range of common interests and offer a wide range of technical electives. Students may double major—aerospace with ocean engineering or ocean with aerospace engineering. The Department also offers a minor in naval engineering, which is open to non-AOE students.

The department's curricula are vehicle oriented, with an emphasis on propulsion, aero/hydrodynamics, stability and control, vehicle performance, vehicle structures, and energy and the environment. A year-long capstone design experience in the senior year uses the group design process to both better simulate the way design is done in the real world and promote the benefits of collaborative learning.

AOE graduates have been highly successful in the aerospace and ocean fields. About 15% of our graduates continue their studies in graduate school, while most of the rest find excellent employment opportunities in the aerospace and related industries and in the shipbuilding, naval engineering, and ship design fields. Some also choose to go into related fields such as automotive engineering, structural engineering, environmental engineering, as well as into professions such as law or medicine.

AOE is home to a number of unique facilities, including Stability, Open-Jet, Boundary-Layer, Low Speed, Transonic, Supersonic, and Hypersonic

Wind Tunnels; the Advanced Propulsion and Power Laboratory (APPL), Space@VT building, the Kentland Experimental Aerial Systems Laboratory (KEAS), the Hydro-Elasticity Laboratory, Hydrodynamics Laboratory, Marine Robotics Laboratory, the Newport News Shipbuilding (NNS) / Aerospace and Ocean Engineering (AOE) Teaching and Research Laboratory, and the Advanced Engineering Design Lab (AEDL).

The department encourages students to seek internships and to participate in the Cooperative Education Program, which gives qualified students valuable industrial experience while working toward their engineering degrees. The department's required design courses often include multidisciplinary projects.

The department also offers programs of study leading to M. Engr., M.S., and Ph.D. degrees.

Program Educational Objectives

The educational objective of our *undergraduate program* is to produce aerospace and ocean engineering graduates who, within five years of completing the BS degree, will be successful in a variety of professional careers, including those outside of traditional aerospace and ocean engineering fields, as evidenced by one or more of the following achievements:

- Creating value by applying the appropriate aerospace and ocean engineering tools to engineering analysis or design of vehicles and systems which operate in the atmosphere, space, and the ocean
- Pursuing professional development via graduate study and/or continuing education in aerospace or ocean engineering or related areas
- Advancing professionally in positions of increasing leadership and/or responsibility within their chosen career field
- Communicating effectively using written, oral, and visual media adapted to different audiences and stakeholders
- Working effectively in multidisciplinary team environments composed of members with varying organizational backgrounds, positions, and geographic locations
- Serving the profession, community, and society, as exemplified in our motto Ut Prosim (That I May Serve)

Student Outcomes

As a result of their completion of the undergraduate program curriculum in Aerospace Engineering or Ocean Engineering, students will attain the following outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. An ability to communicate effectively with a range of audiences
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Accreditation

The undergraduate Aerospace and Ocean Engineering programs are accredited by the Engineering Accreditation Commission of ABET:

- **Aerospace Engineering** is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and the Program Criteria for Aerospace and Similarly Named Engineering Programs.
- **Ocean Engineering** is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org, under the commission's General Criteria and the Program Criteria for Ocean and Similarly Named Engineering Programs.

Pathways General Education

AOE undergraduate students must meet all Pathways requirements and only certain "free" electives and courses designated as "P/F Only" may be taken on a Pass/Fail basis. Lists of approved electives including technical, math, Liberal Education, and other electives are available on the department's web page: http://www.aoe.vt.edu/undergrad/undergrad-advising/index-undergrad-advising.html.

- Aerospace Engineering Major (p. 777)
- Ocean Engineering Major (p. 783)

Head and Fred D. Durham Professor: E.M. Atkins
Assistant Head for Academic Affairs: G.D. Seidel
Assistant Head for Laboratory Facilities: M.K. Philen
Assistant Head for Graduate Studies: O. Coutier-Delgosha
Alumni Distinguished Professor: W.J. Devenport
Kevin Crofton Professor: W.J. Devenport and M.L. Psiaki
NAVSEA Chair Professor: A.J. Brown
Norris and Laura Mitchell Professor: R. K. Kapania
Rolls-Royce Commonwealth Professor of Marine Propulsion: E.G. Paterson
Professor of Practice: P. Artis
Professors: E.M. Atkins, S. Brizzolara, A.J. Brown, R.A. Canfield, O. Coutier-Delgosha, W.J. Devenport, M. Farhood, R.K. Kapania, K.T. Lowe, E.G. Paterson, M.K. Philen, M.L. Psiaki, S.D. Ross, C.J. Roy, G.D. Seidel, C. Sultan, and C.A. Woolsey
Collegiate Professors: B. Davoudi and K.A. Shinpaugh
Associate Professors: W.N. Alexander, S. England, Y. Fu, C.M. Gilbert, J. Jaworski, L. Massa, K.G. Wang, and G. Young
Assistant Professors: B. Denby, R. Fitzgerald, S. Jaiswal, M. Joerger, L. Joseph, C. Neary, M. Priyadarshini, and S. Saha
Adjunct Professors: S. Choi, W. Grossman, L. Ma, W. Oberkampf, M. Patil, J. Pitt, and H. Xiao
Research Professors: E. Aguirre, G. Bo Byun, A. Borgoltz, N. Intaratep, S. P. Kenyon, and J. Song.
Professors Emeritus: E.M. Cliff, W.C. Durham, B. Grossman, E.R. Johnson, J.F. Marchman, W.L. Neu, J. Schetz, R.L. Simpson, and R. Walters
Faculty Affiliates: P. Acar, S. Bailey, R. Batra, J. Gilbert, E. Jacques, K. Kochersberger, A. L'Afflitto, J. Meadows, W. Ng, W. Scales, M.K. Spakovsky, D. Stilwell, and, L. Watson

E-mail: aoe-undergrad-advising-g@vt.edu

Undergraduate Course Descriptions (AOE)

AOE 2024 - Thin-Walled Structures (3 credits)
Basic structural elements of stringer-stiffened thin-walled structures, forces, moments, stresses, and deformation of segmented bars/beams, flexure stress and deflection of beams principal plane, plane of bending and plane of loading for beams with asymmetric cross sections, stresses, and twist due to torsion, shear flow and shear center in open and closed stiffened thin-walled structures, stiffened multicell beams, materials properties and selection.
Prerequisite(s): (ESM 2104 and ESM 2204) or ESM 2114 and (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2054 - Electronics for Aerospace and Ocean Engineers (3 credits)
Electrical circuits. Discrete passive and active electrical components. Phasors and impedence. AC power analysis. Digital electronics. Electronics for autonomous and piloted aerospace and ocean systems. Electronics for vehicle navigation, guidance, and control. Instrumentation and data acquisition systems.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 2074 - Computational Methods (2 credits)
Solving engineering problems using numerical methods and software, truncation and round-off error, root finding, linear and polynomial regression, interpolation, splines, numerical integration, numerical differentiation, solution of linear simultaneous equations. A grade of C- or better is required in the prerequisite.
Prerequisite(s): (ENGE 1216 or ENGE 1434 or ENGE 1414) and (CS 1044 or CS 1064 or CS 1114)
Instructional Contact Hours: (1.5 Lec, 1.5 Lab, 2 Crd)

AOE 2104 - Introduction to Aerospace Engineering and Aircraft Performance (3 credits)
Overview of aerospace engineering from a design perspective; introductory aerodynamics, lift, drag, and the standard atmosphere; aircraft performance, stability, and control; propulsion; structures; rocket and spacecraft trajectories and orbits.
Prerequisite(s): PHYS 2305
Corequisite(s): ESM 2104 or ESM 2114.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2114 - Fundamentals of Flight Training AOE (3 credits)
Foundational course to prepare students with knowledge of basic aeronautics to take the Federal Aviation Administration Knowledge Exam, a requirement for the award of a private pilots license. Explores airplane systems and functions, flight operations, weather, aeronautical navigation, communications, human factors, and federal aviation regulations.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2204 - Introduction to Ocean Engineering (3 credits)
Introduction to the design of ocean vehicles and offshore structures. Buoyancy. Hull geometry, body plan drawing, coefficients of form. Hydrostatic calculations. Intact and damaged stability of ocean vehicles and offshore structures. Large angle stability. Stability criteria for design and related rules and regulations. Marine economics.
Prerequisite(s): PHYS 2305
Corequisite(s): MATH 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 2664 - Exploration of the Space Environment (3 credits)
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment, space weather hazards and societal impacts, orbital mechanics and rocket propulsion, spacecraft subsystems, applications of space-based technologies.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 2164

AOE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 3014 - Fluid Dynamics for Aerospace and Ocean Engineers (3 credits)
Fundamentals of fluids: stress, statics, viscosity, laminar and turbulent flow. Conservation of mass and momentum. Vorticity, circulation, and lift. Navier-Stokes equations. Ideal flow in two dimensions, streamlines, stream function, velocity potential, superposition. Thin airfoil theory. Physics of laminar and turbulent boundary layers and of transition. Boundary layer equations and basic tools for boundary layer calculation. Collaborative problem solving.
Prerequisite(s): (AOE 2104 or AOE 2204) and (MATH 2214 or MATH 2214H or MATH 2406H) and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3034 - System Dynamics and Control (3 credits)
Free and forced response of first, second, and higher order linear, time-invariant (LTI) systems in frequency and time domains. Modeling of low-order mechanical systems. Transmission and absorption of vibrations. Transient and steady state performance specifications. Introduction to closed-loop control using proportional-integral-derivative (PID) feedback. Closed-loop stability analysis using root locus method.
Prerequisite(s): ESM 2304 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3044 - Boundary Layer and Heat Transfer (3 credits)
Concepts of viscous flows and physical properties equations of laminar motion with heat and mass transfer; exact and approximate solutions; finite-difference methods; transition to turbulence; analysis in turbulent flows. Conduction and convective heat transfer.
Prerequisite(s): AOE 3014 and (AOE 3164 or AOE 3264 or ME 2134 or ME 3134) and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3054 - Experimental Methods (3 credits)
Fundamental terminology of experimental work and testing in aerospace and ocean engineering. Flow quantities, displacement, and strain measurements of simple structures in both static and dynamic settings. Analog and digital instrumentation. Data acquisition systems and appropriate software. Through teamwork design, prepare, and conduct an experiment, and document its results and findings. Ethics of technical reporting, through proper external source citation and honestly describing procedures and reporting data. Statistical concepts.
Prerequisite(s): AOE 2024 and AOE 2054 and AOE 3014 and AOE 3034
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 3114 - Aerodynamics & Compressibility (3 credits)
Inviscid aerodynamics. Wings and wing theory for low speed flight. How and when compressibility becomes important. Integral form of the conservation equations and thermodynamics. One-dimensional steady compressible flow, nozzle flows. Compressible flow with heat addition. Oblique shock waves and Prandtl-Meyer expansions. Supersonic airfoils. Aerodynamics at subsonic and transonic speeds.
Prerequisite(s): AOE 3014
Corequisite(s): AOE 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3124 - Aerospace Structures (3 credits)
Inertia loads on aerospace structures, introduction to 3D elasticity including strain-displacement relations, stress-strain relations, stress transformation, and equations of equilibrium, plane stress and plane strain elasticity, stress concentration factors, aerospace materials and failure criteria, margins of safety analysis, plate bending, structural stability.
Prerequisite(s): AOE 2024 or AOE 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3134 - Air Vehicle Dynamics (3 credits)
Nonlinear kinematic and dynamic equations of aircraft motion; estimation of stability derivatives from aircraft geometry; determination of steady motions; linearization; longitudinal and lateral-directional small perturbation equations; static and dynamic stability of equilibrium flight.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3144 - Space Vehicle Dynamics (3 credits)
Attitude representations and equations of rotational motion for rigid and multibody spacecraft; attitude determination; linearization and stability analysis of steady motions; effect of the gravity gradient; torque thrusters and momentum exchange devices.
Prerequisite(s): AOE 3034 and AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3154 - Astromechanics (3 credits)
This course teaches the application of Newtons Laws to the dynamics of spaceflight. Topics include the two-body problem equations of motion, Keplers Laws, classical orbital elements, energy and time-of-flight relations, orbit specification and determination, orbital maneuvering and orbit transfers, patched conic approximations, and relative motion.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3164 - Aerothermodynamics and Propulsion Systems (3 credits)
The fundamental principles of aerothermodynamics applied to aerospace propulsion system performance analysis and design. Foundations of thermodynamics, heat transfer, compressible fluid mechanics, and combustion. Applications of principles to air-breathing and rocket engines.
Prerequisite(s): AOE 3014
Corequisite(s): AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3214 - Ocean Wave Mechanics (3 credits)
Introduction to theory of wave in deep and shallow water, including wave generation and propagation. Description of wave statistics and spectral representation for realistic ocean conditions. Introduction to ocean acoustics.
Corequisite(s): 3014, MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3224 - Ocean Structures (3 credits)
Overview of surface ship, submarine and offshore structural systems, materials and loadings. Application of beam and plate bending and buckling theories. Frame structural analysis. Fatigue analysis.
Prerequisite(s): AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3234 - Ocean Vehicle Dynamics (3 credits)
Nonlinear kinematic and dynamic equations of rigid vessel motion in water; hydrostatic and hydrodynamic forces in calm water; motion response to regular and irregular waves; single, multiple and coupled motions degrees of freedom; spectral analysis of response of random seas; statistical analysis of extreme motion response; impact of seakeeping criteria on ocean vehicles design; principles of hydroelasticity; principles of maneuvering of surface and underwater vehicles.
Prerequisite(s): AOE 3014 and AOE 3034 and AOE 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3264 - Thermodynamics and Marine Propulsion (3 credits)
Fundamental thermodynamics and power cycles; marine propulsion plants and transmission systems; methods of estimating resistance of ocean vehicles; propulsion devices and their efficiencies; introduction to propeller theory; cavitation.
Prerequisite(s): AOE 2204 and AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3354 - Avionics Systems (3 credits)
A systems approach to avionics architecture for both civil and military aircraft. Emphasis on system architecture, accepted development processes, sensors, navigation, and certification. Evolution of communications, data models, and sensors required to support autonomous flight as well as the exposures to physical cyber security threats faced by flight management, navigation, and data interchange systems.
Prerequisite(s): AOE 2054 or ECE 2054
Corequisite(s): AOE 3034 or ME 3534 or ME 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3564 - Principles of Project Design and Management (3 credits)
Fundamental principles of model-based project design. Creation of plans for successful development of complex systems such as air, space, and ocean vehicles. Understanding of engineering project performance including emergent scope, cost, and schedule. Systems thinking and systems engineering methods applied to engineering projects as systems: stakeholders, scope, dependence and teamwork dynamics; cost and schedule tradespace; risk assessment and mitigation strategies; and choices in project architecture and organization. Basics of effective teamwork, team building, leadership, and management. Basic understanding of ethical reasoning and conflict management aspects. Oral presentations for design reviews. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 3804 - Special Topics in Aircraft Systems (3 credits)
Advanced undergraduate topics in aircraft systems. Covers technical, environmental, and economic challenges and opportunities in contemporary and future aircraft. Function and integration of propulsion, airborne auxiliary power, navigation, flight controls, cargo, landing gear, cabin systems, fuel, and other subsystems. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): AOE 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

AOE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4004 - State-Space Control (3 credits)
Control design and analysis for linear, state-space system models. Properties of linear, time-invariant control systems: Input/output stability, internal stability, controllability, and observability. Performance and robustness measures. State feedback control design methods: pole placement, linear-quadratic control. State observers and output feedback control. Applications to control of mechanical systems including ocean, atmospheric, and space vehicles.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4024 - An Introduction to the Finite Element Method (3 credits)
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied.
Prerequisite(s): (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) or (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4734

AOE 4034 - Introduction to Mechanical and Structural Vibrations (3 credits)
Free and forced vibrations of single-degree-of-freedom systems, multi-degree-of-freedom systems, and continuous systems. Natural frequencies and mode shapes. Proportional and nonproportional damping. Response to harmonic, periodic, and nonperiodic excitations. Boundary-value problem for continuous systems. Eigenvalue problem for rods, beams, and plates. Vibration response of system in modal coordinates. Approximate methods including Assumed Modes, the Rayleigh-Ritz method, and Method of Weighted Residuals.
Prerequisite(s): AOE 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4054 - Stability of Structures (3 credits)
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion.
Prerequisite(s): AOE 2024 or AOE 3024 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4444

AOE 4064 - Fluid Flows in Nature (3 credits)
Course designed to build upon and broaden a basic traditional engineering knowledge of fluid flows into areas concerning a variety of natural occurrences and phenomena that involve fluid motions in important ways. Drag of sessile systems and motile animals, gliding and soaring, flying and swimming, internal flows in organisms, low Reynolds number flows, fluid-fluid interfaces, unsteady flows in nature and wind engineering.
Prerequisite(s): AOE 3014 or CEE 3304 or ESM 3024 or ME 3404 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4065 - Air Vehicle Design (3 credits)
Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and AOE 3134 and AOE 3164
Corequisite(s): AOE 4105
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4066 - Air Vehicle Design (3 credits)
Fundamental principles of innovative air vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4065: Proven conceptual design process. Tradeoff studies. Air vehicle weight estimation. Air vehicle concepts feasibility assessment; 4066: Preliminary design tools and processes. Efficient and light-weight air vehicles. Air vehicle design validation.
Prerequisite(s): AOE 4065
Corequisite(s): AOE 4106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4084 - Engineering Design Optimization (3 credits)
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4084

AOE 4105 - Experiments for Aerospace Design (1 credit)
Methods for the planning, implementation, assessment and use of experiments in aerospace design problems. 4105: Experiment design, advanced sensor systems, additive manufacturing, uncertainty, data analysis and reporting. 4106: Application of experiments as an integral component of engineering design. Co: 4066 or 4166 for 4106.
Prerequisite(s): AOE 3054
Corequisite(s): 4065 or 4165 for 4105. 4066 or 4166 for 4106.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4106 - Experiments for Aerospace Design (1 credit)
Methods for the planning, implementation, assessment and use of experiments in aerospace design problems. 4105: Experiment design, advanced sensor systems, additive manufacturing, uncertainty, data analysis and reporting. 4106: Application of experiments as an integral component of engineering design. Co: 4066 or 4166 for 4106.
Prerequisite(s): AOE 4105
Corequisite(s): 4065 or 4165 for 4105. 4066 or 4166 for 4106.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4114 - Applied Computational Aerodynamics (3 credits)
Development of computational methods for application to wing aerodynamic problems. Incompressible airfoil codes. Panel methods and vortex lattice methods. Finite difference techniques. Transonic and supersonic applications.
Prerequisite(s): AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4124 - Configuration Aerodynamics (3 credits)
Aerodynamic design of flight vehicles, with emphasis on nonlinear flowfields and configuration concepts. Aerodynamic analysis and design for transonic, supersonic, hypersonic flows, and low speed high alpha flight. Includes case studies of classic configurations and aerodynamic design papers.
Prerequisite(s): AOE 3014 and AOE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4140 - Spacecraft Dynamics and Control (3 credits)
Space missions and the way pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modeling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational maneuvers. Environmental torques. Impacts of attitude stabilization techniques on mission performance.
Prerequisite(s): AOE 3034 and (AOE 4134 or AOE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4165 - Space Vehicle Design (3 credits)
Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and AOE 3144 and AOE 3154 and AOE 3164
Corequisite(s): AOE 4105
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4166 - Space Vehicle Design (3 credits)
Fundamental principles of innovative space vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary design teams with emphasis on collaboration, ethics, and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4165: Proven conceptual design process. Parametric analyses. Space vehicle mass estimation. Space vehicle concepts feasibility assessment; 4166: Preliminary design tools and processes. Efficient and light-weight space vehicles. Space vehicle design validation.
Prerequisite(s): AOE 4165
Corequisite(s): AOE 4106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4174 - Spacecraft Propulsion (3 credits)
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues.
Prerequisite(s): AOE 3164 or AOE 4234 or ME 4234
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4174

AOE 4205 - Experiments for Ocean Vehicle Design (1 credit)
4205: Facilities, instrumentation, and experiments pertinent to ocean engineering in the field of flow measurements and resistance and propulsion tests of surface and underwater vehicles. Analysis and communication of experimental data through technical report writing. 4206: Assessment of ocean system design through experiments, data analysis, and technical report writing.
Prerequisite(s): AOE 3054
Corequisite(s): AOE 4265
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4206 - Experiments for Ocean Vehicle Design (1 credit)
4205: Facilities, instrumentation, and experiments pertinent to ocean engineering in the field of flow measurements and resistance and propulsion tests of surface and underwater vehicles. Analysis and communication of experimental data through technical report writing. 4206: Assessment of ocean system design through experiments, data analysis, and technical report writing.
Prerequisite(s): AOE 3054
Corequisite(s): AOE 4266
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

AOE 4224 - Atmospheric and Ocean Vehicle Model Identification (3 credits)
Atmospheric and ocean vehicle dynamic modeling from experimental data including: experiment design; model structure determination; parameter and state estimation; and data analysis methods. Regression and maximum likelihood approaches. Time and frequency domain formulations. Applications to airplanes, rotorcraft, surface vessels, and undersea vehicles.
Prerequisite(s): AOE 3134 or AOE 3234
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4234 - Aerospace Propulsion Systems (3 credits)
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements.
Prerequisite(s): AOE 3114 and (AOE 3164 or AOE 3264) or ME 3414 and ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4234

AOE 4244 - Naval and Marine Engineering Systems Design (3 credits)
Concepts, theory and methods for the design, integration, and assessment of naval and marine engineering systems considering energy conservation, ship arrangements, system deactivation diagrams, reliability, maintenance, system power, shock and weapons effects, machinery sizing, and system vulnerability. Physics-based mechanical, electrical, thermal, sensor, control, weapon systems, hullform and engine (diesel and gas turbine) models are used to predict total system performance. Linear programming methods and flow-based models are used to optimize systems architecture and size components.
Prerequisite(s): AOE 3264
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4264 - Principles of Naval Engineering (3 credits)
This course studies naval engineering systems and systems engineering processes with particular emphasis on: naval missions; combat system performance including radar; underwater acoustics and sonar; ballistics; weapon propulsion and architecture; weapons effects; ship survivability including underwater explosion and shock waves; surface ship and submarine balance and feasibility analysis; and total ship integration. Senior Standing required.
Prerequisite(s): (MATH 2224 or MATH 2204 or MATH 2204H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4265 - Ocean Vehicle Design (3 credits)
Study and application of systems engineering process and ocean engineering principles to the concept exploration, design and development of ocean vehicles including ships, submarines, surface and subsurface autonomous vehicles, boats and yachts. 4265: Emphasis on hullform, power and propulsion, synthesis, balance, metrics and design optimization. 4266: Emphasis on topside/external arrangements, internal arrangements, machinery arrangements, human systems, structural design, and final assessments of intact and damage stability, weights, space, seakeeping, cost, risk, overall balance and feasibility. Most of the work is done in teams.
Prerequisite(s): AOE 2204 and AOE 3214 and AOE 3224 and AOE 3234 and AOE 3264
Corequisite(s): AOE 4205
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4266 - Ocean Vehicle Design (3 credits)
Study and application of systems engineering process and ocean engineering principles to the concept exploration, design and development of ocean vehicles including ships, submarines, surface and subsurface autonomous vehicles, boats and yachts. 4265: Emphasis on hullform, power and propulsion, synthesis, balance, metrics and design optimization. 4266: Emphasis on topside/external arrangements, internal arrangements, machinery arrangements, human systems, structural design, and final assessments of intact and damage stability, weights, space, seakeeping, cost, risk, overall balance and feasibility. Most of the work is done in teams.
Prerequisite(s): AOE 4265
Corequisite(s): AOE 4206
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4274 - Intermediate Ship Structural Analysis (3 credits)
Analysis of plate bending, buckling, and ultimate strength using computational tools and methods. Calculation of elastic buckling of stiffened panels. Eigenvalue methods for buckling and vibration. Incremental plastic collapse; other progressive collapse. Ultimate strength of large structural modules due to combined loads. Introductory level finite element analysis.
Prerequisite(s): AOE 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4324 - Energy Methods for Structures (3 credits)
Work and energy relationships in structures, flexibility and stiffness influence coefficients, Maxwell and Betti-Rayleigh reciprocal theorems, strain energy and complementary strain energy for thin-walled structures, Castigliano's first and second theorems for trusses and frames, unit action and unit displacement states, direct stiffness method, principles of minimum total potential energy and total complementary energy for bars, beams, and plates, Ritz method, finite element method for bars and beams.
Prerequisite(s): AOE 2024 and (AOE 3124 or AOE 3224)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4334 - Ship Dynamics (3 credits)
Analysis of motions of rigid body vehicles in water, including influence of added mass and buoyancy. Seakeeping motion responses in waves, wave-induced structural loads, random response analysis via spectral analysis, and extreme response analysis. Introduction to hydroelasticity and maneuvering.
Prerequisite(s): AOE 3014 and AOE 3034 and (AOE 3214 or AOE 4214) and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4344 - Dynamics of High-Speed Marine Craft (3 credits)
Introduction to the dynamics of high-speed craft, including surface effect ships, hydrofoil vessels, semi-displacement monohulls and catamarans, and planing vessels.
Prerequisite(s): AOE 3264
Corequisite(s): 4334 or 3234.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4365 - Launch Vehicle Design (3 credits)
Fundamental principles of innovative launch vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary (e.g., propulsion, structures, orbital mechanics, economics, or aerodynamics) design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4365: Proven conceptual design process. Tradeoff studies. Launch vehicle weight estimation. Launch vehicle concepts feasibility assessment; 4366: Preliminary design tools and processes. Efficient and light-weight launch vehicles. Launch vehicle design validation. Launch vehicle operation.
Prerequisite(s): AOE 2104 and AOE 3054 and AOE 3114 and AOE 3124 and (AOE 3134 or AOE 3144) and AOE 3164
Corequisite(s): AOE 4105
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4366 - Launch Vehicle Design (3 credits)
Fundamental principles of innovative launch vehicle design. Qualitative and quantitative decision-making tools. Multidisciplinary (e.g., propulsion, structures, orbital mechanics, economics, or aerodynamics) design teams with emphasis on ethics and professionalism. Project risks and mitigation plans. Oral presentations for design reviews. Written engineering design report. 4365: Proven conceptual design process. Tradeoff studies. Launch vehicle weight estimation. Launch vehicle concepts feasibility assessment; 4366: Preliminary design tools and processes. Efficient and light-weight launch vehicles. Launch vehicle design validation. Launch vehicle operation.
Prerequisite(s): AOE 4365
Corequisite(s): AOE 4106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

AOE 4404 - Applied Numerical Methods (3 credits)
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and MATH 4404.
Prerequisite(s): MATH 4564 and (ESM 2074 or AOE 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MATH 4404

AOE 4414 - Computer Aided Space Mission Analysis (3 credits)
Advanced space mission design, requirements development, and analysis. Analyses of current and future space systems and missions, space platform and payload concepts. Orbital mechanics; coverage; space-to-ground and space-to-space communications; remote sensing; disaggregation; infrastructure; terrain modeling; space vehicle and payload performance constraints, dynamics, and degradation; homogeneous and heterogeneous constellations; launch; the space environment; space mission environmental and economic impact; and mission modeling and simulation for Earth orbit, interplanetary, and CisLunar regimes.
Prerequisite(s): (AOE 2074 or ESM 2074 or ECE 2504) and (AOE 2664 or ECE 2164 or AOE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4434 - Introduction to Computational Fluid Dynamics (3 credits)
Euler and Navier-Stokes equations governing the flow of gases and liquids. Mathematical character of partial differential equations. Discretization approaches with a focus on the finite difference method. Explicit and implicit solution techniques and their numerical stability. Introduction to verification, validation, and uncertainty quantification for computational fluid dynamics predictions.
Prerequisite(s): MATH 2214
Corequisite(s): AOE 3044 or ME 3404 or ESM 3016.
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4454 - Spacecraft Position/Navigation/Timing and Orbit Determination (3 credits)
Position/Navigation/Timing (PNT) measurements and optimal batch filter estimation methods for spacecraft with emphasis on orbit determination; GPS position/velocity/time point solutions; linearized state transition matrices; batch least-squares filter Orbit Determination (OD) solutions from a time series of observations; precision and accuracy assessment using covariance and overlap statistics; one-way and two-way radio range and range-rate observations; optical bearings observations; non-Keplerian orbital effects.
Prerequisite(s): AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4464 - Introduction to Global Positioning System (GPS) Theory and Design (4 credits)
Fundamental theory and applications of radio navigation with the Global Positioning System GPS. Satellite orbit theory, GPS signal structure and theory, point positioning with pseudoranges and carrier phases, selective availability, dilution of precision, differential GPS, atmospheric effects on GPS signals.
Prerequisite(s): ECE 3105 or AOE 4134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ECE 4164

AOE 4474 - Propellers and Turbines (3 credits)
Theory, numerical methods, and experimental techniques for analysis and design of propellers and turbines. Geometry description and creation of computer models. Analysis of inflow from wakes and atmospheric boundary layers. Performance characteristics including open-water and multi-quadrant operation, scale effects, and standard series data. Theoretical analysis and selection of airfoil and hydrofoil sections. Theory and numerical methods for propellers and turbines, including computational fluid dynamics (CFD) simulation. Design of wake-adapted propellers. Design of wind-turbine rotors in steady wind. Structural analysis of propeller and turbine blades. Wind- and water-tunnel testing for thrust and torque.
Prerequisite(s): AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4514 - Nonlinear Dynamics and Chaos (3 credits)
Motion of systems governed by differential equations: stability, geometry, phase planes, bifurcations, Poincare sections, point attractors, limit cycles, chaos and strange attractors, Lyapunov exponents. Forced, nonlinear oscillations: jump phenomena, harmonic resonances, Hopf bifurcations, averaging and multiple-scales analysis. Systems governed by discrete maps: return maps, cobweb plots, period-multiplying bifurcations, intermittency, delay coordinates, fractal dimensions.
Prerequisite(s): (ESM 2304 or PHYS 2504) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4114

AOE 4604 - Booster Design, Fabrication, and Operation (3 credits)
Theory, design, operations, and fabrication methodologies employed to manufacture boosters. The rocket equation, solid, liquid, and hybrid propellant systems, combustion chamber design, vehicle structures, telemetry, guidance and navigation, launch operations, and failure modalities.
Prerequisite(s): AOE 2074 and AOE 3124 and AOE 3154 and AOE 3164
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4614 - Aerospace Materials and Modeling Techniques (3 credits)
Aircraft, spacecraft structural and engine materials. Mechanical, thermal properties and chemical stability of metallic materials. Aluminum, iron, nickel and titanium -based alloys. Atomistic structure, elastic properties, elastic anisotropy and microscopic origins. Plasticity, dislocations, and strengthening mechanism. Liquid-solid and solid-state phase transformation in alloys. Facture, creep and fatigue. Oxidation and corrosion. Simulating materials behaviors using molecular dynamics techniques.
Prerequisite(s): CHEM 1035 and PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4624 - Foundations of Aero and Hydroacoustics (3 credits)
Fundamental background to the field of aero/hydroacoustics. Quantifying sound levels, acoustic intensity, the acoustic wave equation, and linear acoustics. Fluid dynamics, turbulence, and thermodynamics in aeroacoustics. Lighthill's equation, and Curle's equation. Characterization and identification of aeroacoustic sources. Leading and trailing edge noise. Basics of aeroacoustic wind tunnel testing.
Prerequisite(s): AOE 3014 and AOE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4634 - Wind Turbine Technology and Aerodynamics (3 credits)
Aerodynamics and elastic behavior of a modern wind turbine. Internal and aerodynamic loads of wind turbines. Locating wind turbines with respect to fatigue, annual power and noise productions. Aeroelastic behavior of wind turbine blades. Generators, transformers and power converters used in wind energy. Historical, economic, political, and innovation issues related to wind energy and power grid integration.
Prerequisite(s): AOE 3014 and (AOE 3124 or AOE 3224)
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4654 - Space Weather: The Solar Wind and Magnetosphere (3 credits)
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earths magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation.
Prerequisite(s): ECE 3105 or AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4154

AOE 4674 - Upper Atmosphere/Ionosphere Space Weather (3 credits)
Interaction of Earth's upper atmosphere and space environment with spacecraft: processes that affect atmospheric density relevant to spacecraft orbit decay; basic composition and structure; radiation and radiative transfer; atmospheric energy balance; atmospheric chemistry and ion production/loss mechanisms; fundamental concepts of Solar-terrestrial physics including ionospheric Chapman theory; atmospheric energy/mass transport; ionospheric electrodynamics; ionospheric storms; planetary atmospheres/ionospheres; instrumentation.
Prerequisite(s): AOE 3014 or ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4174

AOE 4804 - Special Topics in Dynamics, Control, and Estimation (3 credits)
Advanced undergraduate topics in dynamics, control, and estimation related to a particular class of aerospace and ocean engineering systems. Sample course topics include navigation and guidance, aircraft flight control, and ocean vessel motion control. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): AOE 4004
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

AOE 4814 - Special Topics in Propulsion (3 credits)
Advanced undergraduate topics in propulsion for aerospace and ocean vehicles. Covers technical, environmental, and economic challenges and opportunities in contemporary and future propulsion concepts. Comparative analyses of conventional and advanced propulsion systems and propulsion/vehicle integration concepts based upon first principles. Topics include distributed propulsion, green propulsion and propulsion/airframe integration. May be repeated with different content for a maximum of 6 credits.
Prerequisite(s): AOE 3164 or AOE 3264
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

AOE 4824 - Special Topics in Energy and the Environment (3 credits)
Advanced undergraduate topics in energy and the environment related to aerospace and ocean engineering systems. Sample course topics include renewable energy and energy management.
Prerequisite(s): AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

AOE 4864 - Special Topics in Space Engineering (3 credits)
Advanced undergraduate topics in space engineering. Covers technical, environmental, and economic challenges and opportunities in contemporary and future space systems and space missions. Comparative analyses of current and future space systems and missions, and space platform and payload concepts. Topics may include remote sensing, disaggregation, infrastructure, and mission modeling and simulation. May be repeated with different content for a maximum of 6 credits.
Prerequisite(s): AOE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

AOE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

AOE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Aerospace Engineering Major

Program Curriculum

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AOE 2024	Thin-Walled Structures	3
AOE 2054	Electronics for Aerospace and Ocean Engineers	3

AOE/ESM 2074	Computational Methods	2
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers	3
AOE 3034	System Dynamics and Control	3
ESM 2114	Statics & Structures	3
ESM 2304	Dynamics	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 4564	Operational Methods for Engineers	3
PHYS 2306	Foundations of Physics	4
Subtotal		33
Major Requirements		
AOE 2104	Introduction to Aerospace Engineering and Aircraft Performance	3
AOE 3114	Aerodynamics & Compressibility	3
AOE 3124	Aerospace Structures	3
AOE 3134	Air Vehicle Dynamics	3
or AOE 3144	Space Vehicle Dynamics	
AOE 3154	Astromechanics	3
AOE 3164	Aerothermodynamics and Propulsion Systems	3
AOE 4105	Experiments for Aerospace Design	1
AOE 4106	Experiments for Aerospace Design	1
Subtotal		20
Major Electives		
Programming Elective		*3*
Select one of the following:		
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Math Elective		*3*
Select one of the following:		
AOE/MATH 4404	Applied Numerical Methods	
or AOE 5404	Numerical Methods for Aerospace and Ocean Engineering	
MATH 4574	Vector and Complex Analysis for Engineers	
STAT 4705	Probability and Statistics for Engineers	
Vehicle Design Choice		*6*
Select one of the following sequences:		
AOE 4065 & AOE 4066	Air Vehicle Design and Air Vehicle Design	
AOE 4165 & AOE 4166	Space Vehicle Design and Space Vehicle Design	
Technical Electives		
Select nine credit hours of Track Technical Electives		9
Select six credit hours of Technical Electives		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
AOE 3054	Experimental Methods (1A)	3
Select one of the following:		
AOE 4105 & AOE 4065	Experiments for Aerospace Design and Air Vehicle Design (1A)	
AOE 4105 & AOE 4165	Experiments for Aerospace Design and Space Vehicle Design (1A)	
Select one of the following:		
AOE 4106 & AOE 4066	Experiments for Aerospace Design and Air Vehicle Design (1A)	
AOE 4106 & AOE 4166	Experiments for Aerospace Design and Space Vehicle Design (1A)	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
ECON 2005	Principles of Economics	3
or ECON 2006	Principles of Economics	
or ECON 2025H	Honors Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours. [1]		
Total Credits		**127**

[1] If a Pathways course is taken that does not double-count Pathways 7 with Pathways 2, 3 or 6a, then three more Pathways credits are needed (130 credits total).

Technical Electives

The AOE department requires 15 credits of technical electives, all of which must be taken on an A-F basis. ***Students are required to take a minimum of 9 credits from one of the approved Tracks.*** The remaining credits must be AOE courses not otherwise required for the AE major or from the list of approved technical electives below. Up to 6 of the 15 credits may be non-AOE technical courses from the list of approved technical electives or from the tracks. Courses other than those below may be acceptable as technical electives; however, substitutions must be approved by the AOE department ***before the course is taken***. Students are responsible for the satisfaction of prerequisites required for their chosen technical electives.

Code	Title	Credits
CEE 4384	Coastal Engineering	3
CEE 4674	Airport Planning and Design	3
CEE 5614	Analysis of Air Transportation Systems	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
CS 1044	Introduction to Programming in C	3
CS 1054	Introduction to Programming in Java	3
If not taking as a programming elective		
CS 1064	Introduction to Programming in Python	3
If not taking as a programming elective		
CS 1114	Introduction to Software Design	3
If not taking as a programming elective		
CS 2064	Intermediate Programming in Python	3
CS 2114	Software Design and Data Structures	3
ECE 3104	Introduction to Space Systems and Technologies	3
ECE 3154	Space Systems - Design and Validation	2
ECE 3714	Introduction to Control Systems	3
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	4
ECE 4194	Engineering Principles of Remote Sensing	3
ECE 4364	Alternate Energy for Climate Sustainability	3
ECE 4624	Digital Signal Processing And Filter Design	3
ECE 4634	Digital Communications	3
ECE 4644	Satellite Communications	3
ENGR 3124	Introduction to Green Engineering	3
ESM/MSE 3054	Mechanical Behavior of Materials	3
ESM 4024	Advanced Mechanical Behavior of Materials	3
ESM 4044	Mechanics of Composite Materials	3
ESM 4114	Nonlinear Dynamics and Chaos	3
ESM 4154	Nondestructive Evaluation of Materials	3
ESM/ME 4194	Sustainable Energy Solutions for a Global Society	3
ESM 4614	Probability-Based Modeling, Analysis, and Assessment	3
GEOG/GEOS 4354	Introduction to Remote Sensing	3
GEOS 3024	Computational Methods in the Geosciences	3
GEOS 3034	Oceanography (for AE majors only)	3
GEOS/GEOG 4354	Introduction to Remote Sensing	3
ISE 4404	Statistical Quality Control	3
MSE 2034	Elements of Materials Engineering	3
MSE/ESM 3054	Mechanical Behavior of Materials	3
MSE 4055	Materials Selection and Design I and II	3
MATH 3214	Calculus of Several Variables	3
MATH 4144	Linear Algebra II	3
MATH 4225	Elementary Real Analysis	3
MATH 4226	Elementary Real Analysis	3
MATH 4234	Elementary Complex Analysis	3
MATH 4245	Intermediate Differential Equations	3
MATH 4425	Fourier Series and Partial Differential Equations	3
MATH 4426	Fourier Series and Partial Differential Equations	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4574	Vector and Complex Analysis for Engineers (if not used as math elective)	3
ME 2134	Thermodynamics	4
ME/ESM 4194	Sustainable Energy Solutions for a Global Society	3
ME 4204	Internal Combustion Engines	3
ME 4224	Gas Turbines for Power and Propulsion	3
ME 4524	Introduction to Robotics and Automation	3
ME 4534	Land Vehicle Dynamics	3
ME 4624	Finite Element Practice in Mechanical Design	3
ME 4634	Introduction to Computer-aided Design and Manufacturing	3
ME 4644	Introduction to Rapid Prototyping	3
ME 4724	Engineering Acoustics	3
MGT 3304	Management Theory and Leadership Practice	3
NSEG 3145	Fundamentals of Nuclear Engr	3
NSEG 3146	Fundamental of Nuclear Engr	3
PHIL/MGT 4324	Business and Professional Ethics	3
PHYS 3324	Modern Physics	4
PHYS 3405	Intermediate Electricity and Magnetism	3
PHYS 3406	Intermediate Electricity and Magnetism	3
PHYS 3655	Introduction to Astrophysics	3
PHYS 3656	Introduction to Astrophysics	3
PHYS 4455	Introduction to Quantum Mechanics	3
PHYS 4456	Introduction to Quantum Mechanics	3
PHYS 4504	Introduction to Nuclear and Particle Physics	3
PHYS 4554	Introduction to Solid State Physics	3
PHYS 4614	Optics	3
STAT 4105	Theoretical Statistics	3
STAT 4106	Theoretical Statistics	3
STAT 4705	Probability and Statistics for Engineers (for AE majors only, if not used as the math elective)	3
STAT 4706	Probability and Statistics for Engineers	3

Track Technical Electives

The AOE department requires 15 credits of technical electives. Students are required to take a minimum of 9 credits from one of the approved Tracks. Up to 6 of the 15 credits may be non-AOE technical courses selected either from Tracks or from the list of approved non-AOE technical courses. If a track includes a foundational course, the foundational course is required in that track, but it does not necessarily need to be taken first unless it is a prerequisite. Students must meet all pre-requisites and enrollment requirements for their select courses. Per the Graduate School policy, courses at the 5000 level are only available to seniors with a 3.0 or above overall GPA and the instructor's permission.

Foundational Track

The courses in the Foundational Track span the core areas in both Aerospace and Ocean Engineering. Achieving greater depth in analysis and understanding of these materials is very useful in building a strong general background in Aerospace and Ocean Engineering, and the Foundational Track allows students to acquire greater depth across the range of core areas in both aerospace and ocean engineering. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
Select a minimum of 9 credit hours of the following:		9
AOE 3044	Boundary Layer and Heat Transfer	
or AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 4004	State-Space Control	
AOE/ESM 4084	Engineering Design Optimization	
AOE 4324	Energy Methods for Structures	
Total Credits		**9**

Aero/Hydrodynamics Track

Aero/Hydrodynamics is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of Fluid Flows about vehicles is critical to the design of those vehicles. The Aero/Hydrodynamics Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 3044	Boundary Layer and Heat Transfer	3
or AOE 5144	Boundary Layer Theory and Heat Transfer	
Select a minimum of 6 credit hours of the following:		6
AOE 4064	Fluid Flows in Nature	
AOE 4114	Applied Computational Aerodynamics	
AOE 4124	Configuration Aerodynamics	
AOE 4434	Introduction to Computational Fluid Dynamics	
AOE 4474	Propellers and Turbines	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 5104	Advanced Aero and Hydrodynamics	
AOE 5114	High Speed Aerodynamics	
AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 5154	Data Analysis in Fluid Dynamics	
Total Credits		**9**

Dynamics, Control and Estimation Track

Dynamics, Control and Estimation is a core topic area in both Aerospace and Ocean Engineering. The ability to model and predict the motion of a vehicle, and to modulate that motion through proper control design, is critical to the design of those vehicle systems. The Dynamics, Control and Estimation Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4004	State-Space Control	3
Select a minimum of 6 credit hours of the following:		6
AOE 3134	Air Vehicle Dynamics (If not taking as required major course)	
AOE 3144	Space Vehicle Dynamics (If not taking as required major course)	
AOE 3234	Ocean Vehicle Dynamics (If not taking as required major course)	
AOE 4344	Dynamics of High-Speed Marine Craft	
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination	
AOE 4514	Nonlinear Dynamics and Chaos	
AOE 4804	Special Topics in Dynamics, Control, and Estimation	
ECE 3714	Introduction to Control Systems	
ECE 4624	Digital Signal Processing And Filter Design	
ESM 4114	Nonlinear Dynamics and Chaos	
ME 4534	Land Vehicle Dynamics	
AOE 5204	Vehicle Dynamics and Control	
AOE 5234	Orbital Mechanics	
AOE 5334	Advanced Ship Dynamics	
AOE 5734	Convex Optimization	
AOE 5744/ ME 5544/ ECE 5744	Linear Systems Theory	
AOE/ECE 5754/ME 5554	Applied Linear Systems	
AOE 5764/ ME 5564/ ECE 5764	Applied Linear Control	
AOE/ECE 5774/ME 5574	Nonlinear Systems Theory	
Total Credits		**9**

Energy and the Environment Track

Energy and the Environment, a major application area in both Aerospace and Ocean Engineering, focuses on imparting specific skills required to understand the nature, scope, and challenges of environmental impact and the science behind energy and propulsion systems that minimize that impact. The Energy and the Environment Track will allow students with a particular interest in environment impact, energy systems and renewable energy to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of 9 credit hours of the following:		9
AOE 4064	Fluid Flows in Nature	
AOE 4474	Propellers and Turbines	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 4634	Wind Turbine Technology and Aerodynamics	
AOE 4824	Special Topics in Energy and the Environment	
AOE 5154	Data Analysis in Fluid Dynamics [1]	
ECE 4364	Alternate Energy for Climate Sustainability	
ENGR 3124	Introduction to Green Engineering	
ESM/ME 4194	Sustainable Energy Solutions for a Global Society	
Total Credits		**9**

Naval Engineering Track

Naval Engineering is an application track in both Aerospace and Ocean Engineering. Understanding naval missions, capability requirements and the broad scope of engineering applications to naval missions, and developing particular technical application knowledge in elective courses, will provide students with a unique and valuable skill set. These skills will enable the student to perform research and work in this field. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4264	Principles of Naval Engineering	3
or AOE 5324	Principles of Naval Engineering with Applications	
Select a minimum of 6 credit hours of the following:		6
AOE 4244	Naval and Marine Engineering Systems Design	
or AOE 5314	Naval and Marine Engineering Systems Design	
AOE 4274	Intermediate Ship Structural Analysis	
AOE 4344	Dynamics of High-Speed Marine Craft	
AOE 4474	Propellers and Turbines	
AOE 5074	Advanced Ship Structural Analysis	
AOE 5314	Naval and Marine Engineering Systems Design	
AOE 5324	Principles of Naval Engineering with Applications	
AOE 5334	Advanced Ship Dynamics	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	
ECE 4364	Alternate Energy for Climate Sustainability	
Total Credits		**9**

Propulsion Track

The study of Propulsion, a core technology in Aerospace and Ocean Engineering, focuses on learning and applying fundamental knowledge to understand the nature, scope, opportunities and challenges of designing, specifying and integrating propulsion technologies. The Propulsion Track will allow students with a particular interest in the design, and analysis of aircraft, spacecraft or ocean propulsion to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of 9 credit hours of the following:		9
AOE 3044	Boundary Layer and Heat Transfer	
AOE 4174	Spacecraft Propulsion	
AOE 4234	Aerospace Propulsion Systems	
AOE 4474	Propellers and Turbines	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 4814	Special Topics in Propulsion	
AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 5154	Data Analysis in Fluid Dynamics	
AOE 5184	High Speed Propulsion	
Total Credits		**9**

Space Engineering Track

Space Engineering is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of the space environment, space payloads, and/or space mission design and operations is critical to the design, analysis, and functioning of those space vehicles and payloads. The Space Engineering Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of 9 credit hours of the following:		9
AOE 2664	Exploration of the Space Environment	
AOE 4174	Spacecraft Propulsion	
AOE 4414	Computer Aided Space Mission Analysis	
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	
AOE 4864	Special Topics in Space Engineering	
AOE/ECE 5174	Introduction to Plasma Science	
AOE 5184	High Speed Propulsion	
AOE 5234	Orbital Mechanics	
ECE 3104	Introduction to Space Systems and Technologies	
ECE 3154	Space Systems - Design and Validation	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	
ECE 4194	Engineering Principles of Remote Sensing	
PHYS 3655	Introduction to Astrophysics	
PHYS 3656	Introduction to Astrophysics	
Total Credits		**9**

Structures and Materials Track

Structures and Materials is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of structural analysis and materials selection for aerospace and ocean vehicles is critical to the design of those vehicles. The Structures and Materials Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4324	Energy Methods for Structures	3
Select a minimum of 6 credit hours of the following:		6
AOE 4024/ ESM 4734	An Introduction to the Finite Element Method	
AOE 4034	Introduction to Mechanical and Structural Vibrations	
AOE 4054/ ESM 4444	Stability of Structures	
AOE 4274	Intermediate Ship Structural Analysis	
AOE 4614	Aerospace Materials and Modeling Techniques	
AOE 5024	Vehicle Structures	
AOE 5034/ ESM 5304	Mechanical and Structural Vibrations	
AOE 5074	Advanced Ship Structural Analysis	
ESM/MSE 3054	Mechanical Behavior of Materials	
ESM 4024	Advanced Mechanical Behavior of Materials	
ESM 4044/ CEE 4610	Mechanics of Composite Materials	
ME 4624	Finite Element Practice in Mechanical Design	
MSE 2034	Elements of Materials Engineering	
Total Credits		**9**

Vehicle and System Design Track

Vehicle and System Design is a core discipline in both Aerospace and Ocean Engineering. Its focus is on imparting specific skills required to understand the nature, scope, and challenges of designing innovative vehicles and systems by synthesizing foundational knowledge from other courses. The Vehicle and System Design Track will allow students with a particular interest in design and operation of aircraft, spacecraft, and ocean vehicles to focus their technical electives. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE/ESM 4084	Engineering Design Optimization	3
Select a minimum of 6 credit hours of the following:		6
AOE 3354	Avionics Systems	
AOE 3564	Principles of Project Design and Management	
AOE 3804	Special Topics in Aircraft Systems (HAW)	
AOE 4124	Configuration Aerodynamics	
AOE 4244	Naval and Marine Engineering Systems Design	
or AOE 5314	Naval and Marine Engineering Systems Design	
AOE 4264	Principles of Naval Engineering	
or AOE 5324	Principles of Naval Engineering with Applications	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4814	Special Topics in Propulsion	
CEE 5614	Analysis of Air Transportation Systems	
Total Credits		**9**

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The AOE Department fully supports this policy. Specific expectations for satisfactory progress for AE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: https://www.undergradcatalog.registrar.vt.edu/
- A student must have at least 2.0 overall and in-major GPAs. (The in-major GPA consists of all courses taken under the AOE designation).

Graduation Requirements

Students must pass all required courses and both the in-major and overall GPA must be at least 2.0 for graduation. The in-major GPA consists of all courses taken under the AOE designation. No courses in this program may be taken on a Pass/Fail basis.

Economics Requirement

ECON 2005 Principles of Economics **is required for graduation** and may be taken as one of the two Concept 3 requirements in the Pathways. If a student chooses to satisfy the Concept 3 requirements with courses not including ECON 2005 Principles of Economics, ISE 2014 Engineering Economy may also be used to satisfy this requirement but this requires additional credits.

ESM 2114 Requirement

ESM 2114 Statics & Structures **is required for graduation.** ESM 2104 Statics and ESM 2204 Mechanics of Deformable Bodies may be substituted in place of ESM 2114 Statics & Structures. However, doing so requires that a student take 6 credits instead of the 3 required for ESM 2114 Statics & Structures.

Aerospace Engineering Primary and Ocean Engineering Secondary

AE primary majors with an OE secondary major may substitute (4065-4066 or 4165-4166) for 4265-4266 and 4105-4106 for 4205-4206 in their secondary OE major (substitutions are not permitted for dual degrees).

Course Offerings

Course offerings are subject to change and the availability of sufficient resources.

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + MATH 2214
3. ESM 2104 + ESM 2204 may be substituted for ESM 2114

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable	4
ENGE 1215	Foundations of Engineering	2
Pathways 2 and/or 7 [1]		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
Select one of the following programming electives.		3
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
	Credits	**16**
Second Year		
Fall Semester		
ESM 2114	Statics & Structures	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
AOE 2054	Electronics for Aerospace and Ocean Engineers	3
AOE 2074	Computational Methods	2

AOE 2104	Introduction to Aerospace Engineering and Aircraft Performance	3
	Credits	**17**
Spring Semester		
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
AOE 2024	Thin-Walled Structures	3
PHYS 2306	Foundations of Physics	4
ECON 2005	Principles of Economics (Pathways 3)	3
	Credits	**16**
Third Year		
Fall Semester		
MATH 4564	Operational Methods for Engineers	3
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers	3
AOE 3034	System Dynamics and Control	3
AOE 3124	Aerospace Structures	3
AOE 3154	Astromechanics	3
	Credits	**15**
Spring Semester		
AOE 3114	Aerodynamics & Compressibility	3
AOE 3134 or AOE 3144	Air Vehicle Dynamics or Space Vehicle Dynamics	3
AOE 3164	Aerothermodynamics and Propulsion Systems	3
AOE 3054	Experimental Methods	3
Track Technical Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
AOE 4105	Experiments for Aerospace Design	1
Vehicle Design Choice		3
Select one of the following	MATH Electives:	3
MATH 4574	Vector and Complex Analysis for Engineers	
MATH 4404	Applied Numerical Methods	
STAT 4705	Probability and Statistics for Engineers	
Track Technical Elective		3
Technical Elective		3
Pathways 6a and/or 7 [1]		3
	Credits	**16**
Spring Semester		
AOE 4106	Experiments for Aerospace Design	1
Vehicle Design Choice		3
Track Technical Elective		3
Technical Elective		3
Pathways 2 and/or 7 [1]		3
Pathways 3 and/or 7 [1]		3
	Credits	**16**
	Total Credits	**127**

[1] Total program credit hours of 127 required is based on a Pathway 7 course double counting with Pathway 2, 3, or 6a. If you elect to complete a Pathway 7 course that does not double count, an additional three Pathway credits will be needed for degree completion (130 credits total).

Ocean Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AOE 2024	Thin-Walled Structures	3
AOE 2054	Electronics for Aerospace and Ocean Engineers	3
AOE/ESM 2074	Computational Methods	2
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers	3
AOE 3034	System Dynamics and Control	3
ESM 2114	Statics & Structures	3
ESM 2304	Dynamics	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 4564	Operational Methods for Engineers	3
PHYS 2306	Foundations of Physics	4
Subtotal		33
Major Requirements		
AOE 2204	Introduction to Ocean Engineering	3
AOE 3214	Ocean Wave Mechanics	3
AOE 3224	Ocean Structures	3
AOE 3234	Ocean Vehicle Dynamics	3
AOE 3264	Thermodynamics and Marine Propulsion	3
AOE 4205	Experiments for Ocean Vehicle Design	1
AOE 4206	Experiments for Ocean Vehicle Design	1
AOE 4265	Ocean Vehicle Design	3
AOE 4266	Ocean Vehicle Design	3
GEOS 3034	Oceanography	3
STAT 4705	Probability and Statistics for Engineers	3
Subtotal		29
Major Electives		
Programming Elective		
Select one of the following programming electives		3
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Technical Electives		
Select nine credit hours of Track Technical electives.		9
Select six credit hours of Technical electives.		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
AOE 3054	Experimental Methods (1A)	3
AOE 4205 & AOE 4265	Experiments for Ocean Vehicle Design and Ocean Vehicle Design (1A)	
AOE 4206 & AOE 4266	Experiments for Ocean Vehicle Design and Ocean Vehicle Design (1A)	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
ECON 2005	Principles of Economics	3
or ECON 2006	Principles of Economics	
or ECON 2025H	Honors Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		

CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours. [1]		
Total Credits		**127**

[1] If a Pathways course is taken that does not double-count Pathways 7 with Pathways 2, 3, or 6a, then three more Pathways credits are needed (130 credits total).

Technical Electives

The AOE department requires 15 credits of technical electives, all of which must be taken on an A/F basis. ***Students are required to take a minimum of 9 credits from one of the approved Tracks.*** The remaining credits must be AOE courses not otherwise required for the AE major or from the list of approved technical electives below. Up to 6 of the 15 credits may be non-AOE technical courses from the list of approved technical electives or from the tracks. Courses other than those below may be acceptable as technical electives; however, substitutions must be approved by the AOE department ***before the course is taken***. Students are responsible for the satisfaction of prerequisites required for their chosen technical electives.

Code	Title	Credits
CEE 4384	Coastal Engineering	3
CEE 4674	Airport Planning and Design	3
CEE 5614	Analysis of Air Transportation Systems	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
CS 1044	Introduction to Programming in C	3
CS 1054	Introduction to Programming in Java	3
If not taking as a programming elective		
CS 1064	Introduction to Programming in Python	3
If not taking as a programming elective		
CS 1114	Introduction to Software Design	3
If not taking as a programming elective		
CS 2064	Intermediate Programming in Python	3
CS 2114	Software Design and Data Structures	3
ECE 3054	Electrical Theory	3
ECE 3104	Introduction to Space Systems and Technologies	3
ECE 3154	Space Systems - Design and Validation	2
ECE 3714	Introduction to Control Systems	3
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	4
ECE 4194	Engineering Principles of Remote Sensing	3
ECE 4364	Alternate Energy for Climate Sustainability	3
ECE 4624	Digital Signal Processing And Filter Design	3
ECE 4634	Digital Communications	3
ECE 4644	Satellite Communications	3
ENGR 3124	Introduction to Green Engineering	3
ESM/MSE 3054	Mechanical Behavior of Materials	3
ESM 4024	Advanced Mechanical Behavior of Materials	3
ESM 4044	Mechanics of Composite Materials	3
ESM 4114	Nonlinear Dynamics and Chaos	3
ESM 4154	Nondestructive Evaluation of Materials	3
ESM/ME 4194	Sustainable Energy Solutions for a Global Society	3
ESM 4614	Probability-Based Modeling, Analysis, and Assessment	3
GEOG 4354	Introduction to Remote Sensing	3
GEOS 3024	Computational Methods in the Geosciences	3
GEOS 3034	Oceanography (for AE majors only)	3
GEOS/GEOG 4354	Introduction to Remote Sensing	3
ISE 4404	Statistical Quality Control	3
MSE 2034	Elements of Materials Engineering	3
MSE/ESM 3054	Mechanical Behavior of Materials	3
MSE 4055	Materials Selection and Design I and II	3
MATH 3214	Calculus of Several Variables	3
MATH 4144	Linear Algebra II	3
MATH 4225	Elementary Real Analysis	3
MATH 4226	Elementary Real Analysis	3
MATH 4234	Elementary Complex Analysis	3
MATH 4245	Intermediate Differential Equations	3
MATH 4425	Fourier Series and Partial Differential Equations	3
MATH 4426	Fourier Series and Partial Differential Equations	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4574	Vector and Complex Analysis for Engineers (if not used as math elective)	3
ME 2134	Thermodynamics	4
ME/ESM 4194	Sustainable Energy Solutions for a Global Society	3
ME 4204	Internal Combustion Engines	3
ME 4224	Gas Turbines for Power and Propulsion	3
ME 4524	Introduction to Robotics and Automation	3
ME 4534	Land Vehicle Dynamics	3
ME 4624	Finite Element Practice in Mechanical Design	3
ME 4634	Introduction to Computer-aided Design and Manufacturing	3
ME 4644	Introduction to Rapid Prototyping	3
ME 4724	Engineering Acoustics	3
MGT 3304	Management Theory and Leadership Practice	3
NSEG 3145	Fundamentals of Nuclear Engr	3
NSEG 3146	Fundamental of Nuclear Engr	3
PHIL/MGT 4324	Business and Professional Ethics	3
PHYS 3324	Modern Physics	4

PHYS 3405	Intermediate Electricity and Magnetism	3
PHYS 3406	Intermediate Electricity and Magnetism	3
PHYS 3655	Introduction to Astrophysics	3
PHYS 3656	Introduction to Astrophysics	3
PHYS 4455	Introduction to Quantum Mechanics	3
PHYS 4456	Introduction to Quantum Mechanics	3
PHYS 4504	Introduction to Nuclear and Particle Physics	3
PHYS 4554	Introduction to Solid State Physics	3
PHYS 4614	Optics	3
STAT 4105	Theoretical Statistics	3
STAT 4106	Theoretical Statistics	3
STAT 4705	Probability and Statistics for Engineers (for AE majors only, if not used as the math elective)	3
STAT 4706	Probability and Statistics for Engineers	3

Track Technical Electives

The AOE department requires 15 credits of technical electives. Students are required to take a minimum of 9 credits from one of the approved Tracks. Up to 6 of the 15 credits may be non-AOE technical courses selected either from Tracks or from the list of approved non-AOE technical courses. If a track includes a foundational course, the foundational course is required in that track, but it does not necessarily need to be taken first unless it is a prerequisite. Students must meet all pre-requisites and enrollment requirements for their select courses. Per the Graduate School policy, courses at the 5000 level are only available to seniors with a 3.0 or above overall GPA and the instructor's permission.

Foundational Track

The courses in the Foundational Track span the core areas in both Aerospace and Ocean Engineering. Achieving greater depth in analysis and understanding of these materials is very useful in building a strong general background in Aerospace and Ocean Engineering, and the Foundational Track allows students to acquire greater depth across the range of core areas in both aerospace and ocean engineering. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
Select a minimum of nine credit hours of the following:		9
AOE 3044	Boundary Layer and Heat Transfer	
or AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 4004	State-Space Control	
AOE/ESM 4084	Engineering Design Optimization	
AOE 4324	Energy Methods for Structures	
Total Credits		**9**

Aero/Hydrodynamics Track

Aero/Hydrodynamics is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of Fluid Flows about vehicles is critical to the design of those vehicles. The Aero/Hydrodynamics Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 3044	Boundary Layer and Heat Transfer	3
or AOE 5144	Boundary Layer Theory and Heat Transfer	
Select a minimum of six credit hours of the following:		6
AOE 4064	Fluid Flows in Nature	
AOE 4114	Applied Computational Aerodynamics	
AOE 4124	Configuration Aerodynamics	
AOE 4434	Introduction to Computational Fluid Dynamics	
AOE 4474	Propellers and Turbines	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 5104	Advanced Aero and Hydrodynamics	
AOE 5114	High Speed Aerodynamics	
AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 5154	Data Analysis in Fluid Dynamics	
Total Credits		**9**

Dynamics, Control and Estimation Track

Dynamics, Control and Estimation is a core topic area in both Aerospace and Ocean Engineering. The ability to model and predict the motion of a vehicle, and to modulate that motion through proper control design, is critical to the design of those vehicle systems. The Dynamics, Control and Estimation Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4004	State-Space Control	3
Select a minimum of six credit hours of the following:		6
AOE 3134	Air Vehicle Dynamics (If not taking as required major course)	
AOE 3144	Space Vehicle Dynamics (If not taking as required major course)	
AOE 3234	Ocean Vehicle Dynamics (If not taking as required major course)	
AOE 4344	Dynamics of High-Speed Marine Craft	
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination	
AOE 4514	Nonlinear Dynamics and Chaos	
AOE 4804	Special Topics in Dynamics, Control, and Estimation	
ECE 3714	Introduction to Control Systems	
ECE 4624	Digital Signal Processing And Filter Design	
ESM 4114	Nonlinear Dynamics and Chaos	
ME 4534	Land Vehicle Dynamics	
AOE 5204	Vehicle Dynamics and Control	
AOE 5234	Orbital Mechanics	
AOE 5334	Advanced Ship Dynamics	
AOE 5734	Convex Optimization	
AOE 5744/ ME 5544/ ECE 5744	Linear Systems Theory	
AOE/ECE 5754/ME 5554	Applied Linear Systems	

AOE 5764/ ME 5564/ ECE 5764	Applied Linear Control
AOE/ECE 5774/ME 5574	Nonlinear Systems Theory
Total Credits	**9**

Energy and the Environment Track

Energy and the Environment, a major application area in both Aerospace and Ocean Engineering, focuses on imparting specific skills required to understand the nature, scope, and challenges of environmental impact and the science behind energy and propulsion systems that minimize that impact. The Energy and the Environment Track will allow students with a particular interest in environment impact, energy systems and renewable energy to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of nine credit hours of the following:		9
AOE 4064	Fluid Flows in Nature	
AOE 4474	Propellers and Turbines	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 4634	Wind Turbine Technology and Aerodynamics	
AOE 4824	Special Topics in Energy and the Environment	
AOE 5154	Data Analysis in Fluid Dynamics	
ECE 4364	Alternate Energy for Climate Sustainability	
ENGR 3124	Introduction to Green Engineering	
ESM/ME 4194	Sustainable Energy Solutions for a Global Society	
Total Credits		**9**

Naval Engineering Track

Naval Engineering is an application track in both Aerospace and Ocean Engineering. Understanding naval missions, capability requirements and the broad scope of engineering applications to naval missions, and developing particular technical application knowledge in elective courses, will provide students with a unique and valuable skill set. These skills will enable the student to perform research and work in this field. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4264	Principles of Naval Engineering	3
Select a minimum of six credit hours of the following:		6
AOE 4244	Naval and Marine Engineering Systems Design	
or AOE 5314	Naval and Marine Engineering Systems Design	
AOE 4274	Intermediate Ship Structural Analysis	
AOE 4344	Dynamics of High-Speed Marine Craft	
AOE 4474	Propellers and Turbines	
AOE 5074	Advanced Ship Structural Analysis	
AOE 5334	Advanced Ship Dynamics	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	
ECE 4364	Alternate Energy for Climate Sustainability	
Total Credits		**9**

Propulsion Track

The study of Propulsion, a core technology in Aerospace and Ocean Engineering, focuses on learning and applying fundamental knowledge to understand the nature, scope, opportunities and challenges of designing, specifying and integrating propulsion technologies. The Propulsion Track will allow students with a particular interest in the design, and analysis of aircraft, spacecraft or ocean propulsion to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of nine credit hours of the following:		9
AOE 3044	Boundary Layer and Heat Transfer	
or AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE/ME 4174	Spacecraft Propulsion	
AOE/ME 4234	Aerospace Propulsion Systems	
AOE 4474	Propellers and Turbines	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4624	Foundations of Aero and Hydroacoustics	
AOE 4814	Special Topics in Propulsion	
AOE 5144	Boundary Layer Theory and Heat Transfer	
AOE 5154	Data Analysis in Fluid Dynamics	
AOE 5184	High Speed Propulsion	
Total Credits		**9**

Space Engineering Track

Space Engineering is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of the space environment, space payloads, and/or space mission design and operations is critical to the design, analysis, and functioning of those space vehicles and payloads. The Space Engineering Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Select a minimum of nine credit hours of the following:		9
AOE 2664/ ECE 2164	Exploration of the Space Environment	
AOE/ME 4174	Spacecraft Propulsion	
AOE 4414	Computer Aided Space Mission Analysis	
AOE 4454	Spacecraft Position/Navigation/Timing and Orbit Determination	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	
AOE 4864	Special Topics in Space Engineering	
AOE/ECE 5174	Introduction to Plasma Science	
AOE 5184	High Speed Propulsion	
AOE 5234	Orbital Mechanics	
ECE 3104	Introduction to Space Systems and Technologies	
ECE 3154	Space Systems - Design and Validation	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	
ECE 4194	Engineering Principles of Remote Sensing	

PHYS 3655	Introduction to Astrophysics	
PHYS 3656	Introduction to Astrophysics	
Total Credits		**9**

Structures and Materials Track

Structures and Materials is a core topic area in both Aerospace and Ocean Engineering. Analysis and understanding of structural analysis and materials selection for aerospace and ocean vehicles is critical to the design of those vehicles. The Structures and Materials Track will allow students with a particular interest in those topics to focus their technical electives in that area. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE 4324	Energy Methods for Structures	3
Select a minimum of six credit hours of the following:		6
AOE 4024/ ESM 4734	An Introduction to the Finite Element Method	
AOE 4034	Introduction to Mechanical and Structural Vibrations	
AOE 4054/ ESM 4444	Stability of Structures	
AOE 4274	Intermediate Ship Structural Analysis	
AOE 4614	Aerospace Materials and Modeling Techniques	
AOE 5024	Vehicle Structures	
AOE 5034/ ESM 5304	Mechanical and Structural Vibrations	
AOE 5074	Advanced Ship Structural Analysis	
ESM/MSE 3054	Mechanical Behavior of Materials	
ESM 4024	Advanced Mechanical Behavior of Materials	
ESM 4044/ CEE 4610	Mechanics of Composite Materials	
ME 4624	Finite Element Practice in Mechanical Design	
MSE 2034	Elements of Materials Engineering	
Total Credits		**9**

Vehicle and System Design Track

Vehicle and System Design is a core discipline in both Aerospace and Ocean Engineering. Its focus is on imparting specific skills required to understand the nature, scope, and challenges of designing innovative vehicles and systems by synthesizing foundational knowledge from other courses. The Vehicle and System Design Track will allow students with a particular interest in design and operation of aircraft, spacecraft, and ocean vehicles to focus their technical electives. This Track is available to all Aerospace and Ocean Engineering majors.

Code	Title	Credits
Required		
AOE/ESM 4084	Engineering Design Optimization	3
Select a minimum of six credit hours of the following:		6
AOE 3354	Avionics Systems	
AOE 3564	Principles of Project Design and Management	
AOE 3804	Special Topics in Aircraft Systems	
AOE 4124	Configuration Aerodynamics	
AOE 4244	Naval and Marine Engineering Systems Design	
or AOE 5314	Naval and Marine Engineering Systems Design	
AOE 4264	Principles of Naval Engineering	
or AOE 5314	Naval and Marine Engineering Systems Design	
or AOE 5324	Principles of Naval Engineering with Applications	
AOE 4604	Booster Design, Fabrication, and Operation	
AOE 4814	Special Topics in Propulsion	
CEE 5614	Analysis of Air Transportation Systems	
Total Credits		**9**

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The AOE Department fully supports this policy. Specific expectations for satisfactory progress for OE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: https://www.undergradcatalog.registrar.vt.edu/
- A student must have at least 2.0 overall and in-major GPAs. (The in-major GPA consists of all courses taken under the AOE designation).

Graduation Requirements

Students must pass all required courses and both the in-major and overall GPA must be at least 2.0 for graduation. The in-major GPA consists of all courses taken under the AOE designation. No courses in this program may be taken on a Pass/Fail basis.

Economics Requirement

ECON 2005 Principles of Economics **is required for graduation** and may be taken as one of the two Concept 3 requirements in the Pathways. If a student chooses to satisfy the Concept 3 requirements with courses not including ECON 2005 Principles of Economics, ISE 2014 Engineering Economy may also be used to satisfy this requirement but this requires additional credits.

ESM 2114 Requirement

ESM 2114 Statics & Structures **is required for graduation.** ESM 2104 Statics and ESM 2204 Mechanics of Deformable Bodies may be substituted in place of ESM 2114 Statics & Structures. However, doing so requires that a student take 6 credits instead of the 3 required for ESM 2114 Statics & Structures.

Ocean Engineering Primary Majors and Aerospace Engineering Secondary Majors

OE primary majors with an AE secondary major may substitute 4265-4266 for (4065-4066 or 4165-4166) and 4205-4206 for 4105-4106 in their secondary AE major (substitutions are not permitted for dual degrees).

Course Offerings

Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + MATH 2214
3. ESM 2104 + ESM 2204 may be substituted for ESM 2114

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable	4
ENGE 1215	Foundations of Engineering	2
Pathways 2 and/or 7 [1]		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
Select one of the following programming electives.		3
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
	Credits	**16**
Second Year		
Fall Semester		
ESM 2114	Statics & Structures	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
AOE 2054	Electronics for Aerospace and Ocean Engineers	3
AOE 2074	Computational Methods	2
AOE 2204	Introduction to Ocean Engineering	3
	Credits	**17**
Spring Semester		
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
AOE 2024	Thin-Walled Structures	3
PHYS 2306	Foundations of Physics	4
ECON 2005	Principles of Economics (Pathways 3)	3
	Credits	**16**
Third Year		
Fall Semester		
MATH 4564	Operational Methods for Engineers	3
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers	3
AOE 3034	System Dynamics and Control	3
AOE 3214	Ocean Wave Mechanics	3
AOE 3224	Ocean Structures	3
	Credits	**15**
Spring Semester		
GEOS 3034	Oceanography	3
AOE 3234	Ocean Vehicle Dynamics	3
AOE 3264	Thermodynamics and Marine Propulsion	3
AOE 3054	Experimental Methods	3
Track Technical Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
AOE 4205	Experiments for Ocean Vehicle Design	1
AOE 4265	Ocean Vehicle Design	3
STAT 4705	Probability and Statistics for Engineers	3
Track Technical Elective		3
Technical Elective		3
Pathways 6a and/or 7 [1]		3
	Credits	**16**
Spring Semester		
AOE 4206	Experiments for Ocean Vehicle Design	1
AOE 4266	Ocean Vehicle Design	3
Track Technical Elective		3
Technical Elective		3
Pathways 2 and/or 7 [1]		3
Pathways 3 and/or 7 [1]		3
	Credits	**16**
	Total Credits	**127**

[1] Total program credit hours of 127 required is based on a Pathway 7 course double counting with Pathway 2, 3, or 6a. If you elect to complete a Pathway 7 course that does not double count, an additional three Pathway credits will be needed for degree completion (130 credits total).

Biological Systems Engineering

Our Website (http://www.bse.vt.edu)

Overview

Biological Systems Engineering connects biology and engineering to solve complex, critical problems in the areas of sustainability, human health, environmental stewardship, and agriculture. The program is invested in our student's success through our curriculum, dedicated advising, hands-on learning opportunities outside the classroom, supportive faculty and staff, scholarship opportunities, and the community atmosphere. Biological Systems Engineering has relatively small class sizes that promote meaningful student-faculty interaction. Departmental courses include significant "hands-on" components and an emphasis on professional skills such as communication, teamwork, and the creative process of engineering design. The department offers over 14 endowed scholarships to students enrolled in Biological Systems Engineering, and students are also eligible for College of Engineering and other Virginia Tech scholarships.

Our program has 2 major options: Biological Systems Engineering (BSE) and Ecological Engineering (EcoE). Students in each of these specialties are provided with a common foundation of biology and chemistry to expand core skills in math, physics, data science, and engineering design principles. The BSE major has multiple paths that provide flexibility in the areas of biotechnology, pre-health, food, environmental health, and ecological engineering. The EcoE major is a structured degree providing the skills and training to solve pressing societal, ecological, and environmental challenges using a holistic, systems approach and integrating nature-based solutions.

The Bachelor of Science in Biological Systems Engineering is offered through the College of Engineering and is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Biological and Similarly Named Engineering Programs.

Program Educational Objectives and Student Outcomes

The BSE program prepares graduates to accomplish the following **program educational objectives** in their careers within a few years after graduation:

1. Our#graduates will apply their engineering problem solving skillset at the intersection of biology and engineering at scales ranging from molecular to global as engineers, entrepreneurs,#or in roles furthering their education.
2. Our#graduates#will contribute to addressing societal and ecological needs in ethical, inclusive, and holistic approaches through#leadership,#collaboration, teamwork, and effective communication.
3. Our#graduates#will advance professionally within their careers through mentoring and life-long learning to meet their own aspirations, improve their organizations, and contribute to their communities.

Our **student learning outcomes** for each student to develop and achieve through the undergraduate program are listed below:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

When combined with career-enhancing opportunities such as Cooperative Education, internships, undergraduate research and study abroad, this educational program enables graduates to make meaningful impacts on challenges involving natural resources and biological systems. Graduates are employed in the biotechnology, pharmaceutical, energy, and food industries as well as government agencies, environmental and ecological consulting firms, and non-profit organizations. Graduates also succeed in professional schools such as medicine, dentistry, and veterinary medicine, and as graduate students in a variety of disciplines.

- Biological Systems Engineering Major (p. 791)
- Ecological Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/biological-systems-engineering/ecological-engineering/)

Department Head: D. R. Edwards
Associate Head for Undergraduate Studies: D. T. Scott
Graduate Program Director: C. W. Hession
H.E. and Elizabeth F. Alphin Professor: Z. M. Easton
Elizabeth and James E Turner Jr Faculty Fellows: L.-A. H. Krometis and C. Zhang
Professors: J. R. Barone, B. L. Benham, Z. M. Easton, D. R. Edwards, W. C. Hession, L.-A. H. Krometis, D.J. Sample, D. T. Scott, J.S. Wayne, and C. Zhang
Associate Professors: J. Arogo Ogejo, F. Batarseh, J. A. Czuba, R. S. Senger, J. E. Shortridge, V. R. Sridhar, T. M. Thompson, and Z. Wang
Assistant Professors: A. Chandel, J. Chen, A. Duraj-Thatte, W. Sun, and R. C. Wright
Academic Advisor: P. Baker

Undergraduate Course Descriptions (AOE)

BSE 1004 - Engineering Biological Systems for the Global Good (1 credit)
Survey of global societal and technological issues that engage biological systems engineers in the areas of health, environment, food and energy. Application of systems-level approaches to meet engineering challenges that intersect with crucial societal issues, including sustainability and equity. Evaluation of key factors that affect the design, communication, and public acceptance of engineered solutions. Analysis of cultural intelligence, with a specific focus on personality and problem solving styles amongst individuals and teams and productive conflict resolution.
Instructional Contact Hours: (1 Lec, 1 Crd)

BSE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2004 - Introduction to Biological Systems Engineering (3 credits)
Introduction to the fundamental concepts of Biological Systems Engineering, including statistics and material and energy balances, through applications in protein separation, hydrology, sediment/nutrient transport, and microbial metabolism. Engineering design process. Engineering problem-solving tools and techniques. Resolving ethical dilemmas. Development of oral and written communication skills; introduction to job searching resources; strategies for career development, and the importance of teamwork and ethics in Biological Systems Engineering.
Prerequisite(s): ENGE 1215 or ENGE 1414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2304 - Landscape Measurements and Modeling (3 credits)
Introduction to land surveying, computer-aided design, and drafting for land and water resources engineering. Representation of features in two and three dimensions for documentation and visualization of watershed engineering projects. Create plans, cross sections, detail drawings, and three dimensional visualizations using computer-aided design and drafting tools.
Prerequisite(s): MATH 1206 or MATH 1226
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3144 - Engineering Analysis for Biological Systems using Numerical Methods (2 credits)
Solving engineering problems related to biological systems using numerical analysis including root finding, numerical integration, differentiation, interpolation and numerical solution of ordinary differential equations. Error analysis and programming with engineering software. Course requirements may be satisfied by taking MATH 2214 prior to or concurrent with course.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (2 Lec, 2 Crd)

BSE 3154 - Thermodynamics of Biological Systems (3 credits)
Description of biological, chemical and mechanical mechanisms of energy storage and conversion to work. Derivation and use of the first and second laws of thermodynamics (energy and entropy) to analyze processes found in biotechnology, ecological engineering, and living systems. Analysis of thermodynamic cycles and their relevance to biological systems. Introduction of Gibbs energy, equilibrium at specified pH, and calorimetry of biological reactions.
Prerequisite(s): CHEM 1036 and PHYS 2305 and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3324 - Small Watershed Hydrology (3 credits)
Precipitation, soil physics, infiltration, evapotranspiration, groundwater hydrology, overland flow, open channel flow, flow routing, hydraulic analysis.
Prerequisite(s): PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3334 - Nonpoint Source Pollution Assessment and Control (3 credits)
Erosion prediction and control; transport and fate of sediment, nutrients, and microorganisms; design of nutrient management plans, wetlands, detention facilities and other management practices for rural and urban nonpoint source pollution control.
Prerequisite(s): BSE 3324
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 3504 - Transport Processes in Biological Systems (3 credits)
Introduction to material and energy balances in biological systems. Fundamentals of heat and mass transfer in biological systems. One and two dimensional conduction, convection, and diffusion of thermal energy and mass. Heat and mass transfer rates, steady and unsteady state conduction, convection, diffusion; design of simple heat exchangers. Application of these topics and fluid mechanics to fluid handling, bacterial growth, plant nutrient uptake, enzymatic reactions.
Prerequisite(s): BSE 3154 and ESM 3024 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3524 - Unit Operations in Biological Systems Engineering (3 credits)
Description of unit operations for processing biological materials including evaporation, drying, gas-liquid separations, adsorption, membrane separation, and mechanical separation.
Prerequisite(s): BSE 3154 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3534 - Bioprocess Engineering (3 credits)
Engineering concepts for biological conversion of raw materials to food, pharmaceuticals, fuels, and chemicals. Metabolic pathways leading to products, enzyme kinetics, cell growth kinetics, and analysis of bioreactors and fermenters.
Prerequisite(s): BSE 3154
Corequisite(s): BIOL 2604, BSE 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4125 - Comprehensive Design Project (2 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126: Complete a comprehensive design project using the team approach, test approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 3334 or BSE 3524
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BSE 4126 - Comprehensive Design Project (3 credits)
4125: Identify and develop an engineering design project using the team approach; use of literature resources to define project objectives and approach; present project proposal in a professional written and oral manner; engineering ethics, professionalism and contemporary issues. Pre: Completion of 96 hours, overall GPA of 2.0 or better. 4126 Complete a comprehensive design project using the team approach, test prototype, and prepare and present a professional engineering design report.
Prerequisite(s): BSE 4125
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BSE 4204 - Instrumentation for Biological Systems (3 credits)
Introduction to instrumentation and sensors for measurement and control of biological systems. Sensor response dynamics, data acquisition, sensor selection, signal processing and signal conditioning principles. Experimental determination of velocity, pressure, strain, displacement, forces and chemical constituents. Data analysis focused on uncertainty, error and statistical concepts.
Prerequisite(s): PHYS 2306 and ESM 3024
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

BSE 4224 - Field Methods in Hydrology (3 credits)
Site characterization: surveying, channel and floodplain mapping, land use, electronic data acquisition. Techniques for measuring surface and subsurface hydrologic processes: water flow, hydrologic conductivity, precipitation, evaporation. Sampling techniques: surface water, groundwater, and soil pore water sampling. In-situ monitoring: automatic samplers, dataloggers, water quality sondes. Laboratory analyses: good laboratory practices, selection of analytical method, calibration, quality assurance/quality control.
Prerequisite(s): BSE 3324 or FREC 3104 or WATR 3104 or CEE 3314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4304 - Introduction to Watershed Modeling (3 credits)
Fundamental modeling principles used to quantifywatershed hydrology, energy budgets,and associated ecosystem functions, such asplant dynamics and biogeochemical processes, at scales ranging from soil poresto watersheds. Code development and model integration to simulate watershed hydrologyandnutrient and sediment transport. Model calibration and performance assessment. Data discovery, acquisition, and processing of data relevant to hydrologic/watershed modeling.
Prerequisite(s): BSE 3334
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4324 - Applied Fluvial Geomorphology (3 credits)
Introduction to landscape evolution. Influence of geology and climate on stream form and processes. Fundamental river mechanics and sediment transport. Stream surveying and classification. River system response to changes in hydrology and sediment supply. Interactions between ecosystems and fluvial systems. Human impacts on stream systems.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4344 - Geographic Information Systems for Engineers (3 credits)
Conceptual, technical, and operational aspects of geographic information systems as a tool for storage, analysis, and presentation of spatial information. Focus on engineering applications in resource management, site selection, and network analysis. Laboratory work and senior standing required.
Prerequisite(s): BSE 3324 or CEE 3314 or FREC 3104 or WATR 3104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BSE 4394 - Water Supply and Sanitation in Developing Countries (3 credits)
Social, economic and engineering principles of water supply and sanitation in developing countries as affected by climate, cultural and sociological factors, and material and financial resources. Pre: Junior or Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4524 - Biological Process Plant Design (3 credits)
Engineering principles for design of systems for processing biological materials into primary and secondary products. Delivery, scheduling, storage requirements, economic analysis. Process control and instrumentation of bioprocessing plants.
Prerequisite(s): BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4534 - Bioprocess Engineering Lab (1 credit)
Unit operations commonly used in processing biological materials, including filtration, heat transfer, ultrafiltration, crystallization, and protein expression by fermentation, purification by chromatography, and characterization by gel electrophoresis.
Prerequisite(s): BSE 3524 and BSE 3534
Instructional Contact Hours: (3 Lab, 1 Crd)

BSE 4544 - Protein Separation Engineering (3 credits)
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software.
Prerequisite(s): BSE 3504 or CHE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4544

BSE 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4554, HORT 4554, LAR 4554, SPIA 4554

BSE 4564 - Metabolic Engineering (3 credits)
Engineering concepts for analyzing, designing, and modifying metabolic pathways to convert raw materials to food, pharmaceuticals, fuels and chemicals. Cell metabolism, pathway design, bioenergetics, regulatory mechanisms, metabolic modeling, and genetic tools.
Prerequisite(s): BSE 3534 or BCHM 4115 or BIOL 3774
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4604 - Food Process Engineering (3 credits)
Analysis and design of food processing operations including thermal pasteurization and sterilization, freezing, extrusion, texturization, and mechanical separation.
Prerequisite(s): BSE 3504 and BSE 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

BSE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BSE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Biological Systems Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 2604	General Microbiology	3
BSE 2004	Introduction to Biological Systems Engineering (C-)	3
BSE 3144	Engineering Analysis for Biological Systems using Numerical Methods (C-)	2
BSE 3154	Thermodynamics of Biological Systems (C-)	3
BSE 3504	Transport Processes in Biological Systems (C-)	3
BSE 4125	Comprehensive Design Project (C-)	2
ESM 2104	Statics	3
ESM 3024	Introduction to Fluid Mechanics	3
ISE 2014	Engineering Economy	2
Subtotal		24
Major Requirements		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BSE 4126	Comprehensive Design Project (C-)	3
CHEM 1036	General Chemistry	3

MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics	4
STAT 3704	Statistics for Engineering Applications	2
Subtotal		24
Restricted Electives		
Select 2 BSE Fundamental Courses		6
Select 1 CHEM Elective		3
Select 3 BSE Electives where 1 course must have a lab component.		9
Select 3 Engineering Topics Electives		9
Select 2 Technical Electives		6
Subtotal		33
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ISE 3034	Technical Communication for Engineers (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F ;)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three Arts credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D ;)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 should be double-counted with either Pathways 2, 3, or 6a to avoid taking additional credit hours.		
Subtotal		47
Total Credits		**128**

BSE Fundamental Elective Sequence

There are 2 fundamental sequences to choose from (6-hours total):

For Watershed Science and Environmental Health: BSE 3324 Small Watershed Hydrology and BSE 3334 Nonpoint Source Pollution Assessment and Control.

For Biotechnology, Food Engineering, and Health Professions: BSE 3524 Unit Operations in Biological Systems Engineering & BSE 3534 Bioprocess Engineering.

Restricted Electives

Biological Systems Engineering (BSE) Electives

(9 credit hours required, where 1 course must have a lab component.)

Code	Title	Credits
BSE 2304	Landscape Measurements and Modeling	3
BSE 4224	Field Methods in Hydrology	3
BSE 4304	Introduction to Watershed Modeling	3
BSE 4324	Applied Fluvial Geomorphology	3
BSE 4344	Geographic Information Systems for Engineers	3
BSE 4524	Biological Process Plant Design	3
BSE 4534	Bioprocess Engineering Lab	1
BSE 4544	Protein Separation Engineering	3
BSE 4564	Metabolic Engineering	3
BSE 4604	Food Process Engineering	3

Chemistry (CHEM) Electives

(3 credit hours required)

Code	Title	Credits
BCHM 2024	Concepts of Biochemistry	3
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CHEM 2514	Survey of Organic Chemistry	3
CHEM 2535	Organic Chemistry	3
CHEM 2565	Principles of Organic Chemistry	3
CHEM 3615	Physical Chemistry	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
ENSC 4314	Water Quality	3
ENSC 4734	Environmental Soil Chemistry	3
GEOS 4634	Environmental Geochemistry	3

Engineering Topics Electives

(9 credit hours required — students must request to be force-added to major-restricted courses)

Code	Title	Credits
BMES 2104	Introduction to Biomedical Engineering	3
BMES 3124	Introduction to Biomechanics	3
BMES 3134	Introduction to Biomedical Imaging	3
BMES 3144	Biomedical Devices	3
BMES 3154	Biosignal Processing and Classification	3
CEE 3104	Introduction to Environmental Engineering	3
CEE 4104	Water and Wastewater Treatment Design	3
CEE 4114	Fundamentals of Public Health Engineering	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
CEE 4144	Air Resources Engineering	3
CEE 4174	Solid and Hazardous Waste Management	3
CEE 4314	Groundwater Resources	3
CEE 4324	Open Channel Flow	3
CEE 4334	Hydraulic Structures	3
CEE 4344	Water Resources Planning	3
ECE 3054	Electrical Theory	3

ECE 4194	Engineering Principles of Remote Sensing	3
ECE 4364	Alternate Energy for Climate Sustainability	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ESM 3054	Mechanical Behavior of Materials	3
ESM 3064	Mechanical Behavior of Materials Laboratory	1
ESM 4044	Mechanics of Composite Materials	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4114	Nonlinear Dynamics and Chaos	3
ESM 4194	Sustainable Energy Solutions for a Global Society	3
ESM 4204	Musculoskeletal Biomechanics	3
FST 4104	Applied Brewing Science and Engineering	3
ISE 2404	Deterministic Operations Research I	3
ISE 3204	Manufacturing Processes	3
ISE 4014	Introduction to Management Systems	3
ISE 4654	Principles of Industrial Hygiene	3
MSE 2034	Elements of Materials Engineering	3
MSE 2054	Fundamentals of Materials Science	3
MSE 3304	Physical Metallurgy	3
MSE 4584	Biomimetic Materials	3
MSE 4604	Composite Materials	3

Technical Electives

(6 credit hours required – students must request to be force-added to major-restricted courses):

- All BIOL 1XXX laboratories and all 2000, 3000, and 4000 level courses, except 3504.
- CHEM 1046 General Chemistry Laboratory and all CHEM 2000, 3000, and 4000 level courses except 4014.
- All MATH 3000 and 4000 level courses except 4044,4625,4626,4644,4664,4754,4964,4974, 4984,4994.
- All 3000, 4000, and 5000 level engineering courses, with no more than 3 credits of undergraduate research and no more than 3 credits of independent study. Technical elective courses cannot double-count for engineering topics elective credit and vice versa.

Code	Title	Credits
AAEC 3314	Environmental Law	3
ALS 3404	Ecological Agriculture: Theory and Practice	3
ALS 4614	Watershed Assessment, Management, and Policy	2
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
BIOL 4164	Environmental Microbiology	3
BMES 4064	Introduction to Medical Physiology	3
BSE 4394	Water Supply and Sanitation in Developing Countries	3
BSE 4554	Creating the Ecological City	3
CS 1044	Introduction to Programming in C	3
CS 1054	Introduction to Programming in Java	3
CS 1064	Introduction to Programming in Python	3
CS 1114	Introduction to Software Design	3
CS 2064	Intermediate Programming in Python	3
CSES 3114	Soils	3
CSES 3124	Soils Laboratory	1
CSES 3614	Soil Physical and Hydrological Properties	3
CSES 4854	Wetland Soils and Mitigation	3
ECE 2164	Exploration of the Space Environment	3
ENSC 3604	Fundamentals of Environmental Science	3
ENSC 3634	Physics of Pollution	3
ENSC 3644	Plant Materials for Environmental Restoration	3
ENSC 4414	Monitoring and Analysis of the Environment	2
ENSC 4764	Bioremediation	3
ENSC 4774	Reclamation of Drastically Disturbed Lands	3
FIW 4324	Genetics of Natural and Mangaged Populations	3
FIW 4614	Fish Ecology	3
FIW 4624	Marine Ecology	3
FREC 4374	Forested Wetlands	3
FREC 4464	Water Resources Policy and Economics	3
FREC 4784	Wetland Hydrology and Biogeochemistry	3
FST 2544	Functional Foods for Health	3
FST 3024	Principles of Sensory Evaluation	3
FST 3114	Wines and Vines	3
FST 3124	Brewing Science and Technology	3
FST 3514	Food Analysis	4
FST 3604	Food Microbiology	4
FST 4504	Food Chemistry	3
GEOG 1514	Introduction to Meteorology	3
GEOG 3104	Environmental Justice, Resources and Development	3
GEOG 3304	Geomorphology	3
GEOG 4354	Introduction to Remote Sensing	3
GEOS 2104	Elements of Geology	3
GEOS 3014	Environmental Geosciences	3
GEOS 3034	Oceanography	3
GEOS 4804	Groundwater Hydrology	3
ISE 4004	Theory of Organization	3
ISE 4304	Global Issues in Industrial Management	3
LAR 3044	Land Analysis and Site Planning	3
MINE 2504	Introduction to Mining Engineering	3
SBIO 2124	Structure and Properties of Sustainable Biomaterials	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SPES 2244	World Crops: Food and Culture	3
SYSB 2024	Fundamentals of Systems Biology	3
SYSB 2034	Mathematical Methods in Systems Biology	3
SYSB 3115	Network Dynamics and Cell Physiology	4
SYSB 3116	Network Dynamics and Cell Physiology	4
UAP 3354	Introduction to Environmental Policy and Planning	3

UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The BSE Department fully supports this policy. Specific expectations for satisfactory progress for BSE majors are as follows:

- Maintain overall and in-major GPAs of at least 2.0 (in-major GPA based on all BSE-prefix courses taken); and,
- Be registered for at least one BSE-prefix course per year

Graduation Requirements

Graduation Requirements:

1. Students must pass all required courses, with a minimum of a C- in all BSE prefix courses.
2. Both the overall and in-major GPA must be at least a 2.0, where in-major GPA is based on all BSE-prefix courses taken.
3. Only free electives and courses only offered on a Pass/Fail basis may be taken as Pass/Fail.

Additional Notes:

1. Students are strongly encouraged to take CHEM 1036 General Chemistry first year Spring semester.
2. Students are encouraged to take BIOL 1105 Principles of Biology and BIOL 1106 Principles of Biology during the first year if their schedule permits.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering (C-)	2
Pathways 2 or 3 or 6A or 7		3
	Credits	**16**
Spring Semester		
CHEM 1036	General Chemistry	3
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
	Credits	**16**
Second Year		
Fall Semester		
BSE 2004	Introduction to Biological Systems Engineering	3
BIOL 1105	Principles of Biology	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2114	Introduction to Linear Algebra	3
ESM 2104	Statics	3
ISE 2014	Engineering Economy	2
	Credits	**17**
Spring Semester		
BSE 3144	Engineering Analysis for Biological Systems using Numerical Methods	2
BIOL 1106	Principles of Biology	3
Pathways Core Concept 2, 3, 6a, or 7		3
MATH 2214	Introduction to Differential Equations	3
PHYS 2306	Foundations of Physics	4
	Credits	**15**
Third Year		
Fall Semester		
BSE Fundamental Course or Technical Elective		3
BSE 3154	Thermodynamics of Biological Systems	3
STAT 3704	Statistics for Engineering Applications	2
ESM 3024	Introduction to Fluid Mechanics	3
CHEM Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
	Credits	**17**
Spring Semester		
BSE Fundamental Course or Technical Elective		3
BSE Fundamental Course		3
BSE 3504	Transport Processes in Biological Systems	3
BIOL 2604	General Microbiology	3
ISE 3034	Technical Communication for Engineers	3
	Credits	**15**
Fourth Year		
Fall Semester		
BSE 4125	Comprehensive Design Project	2
BSE Elective		3
BSE Elective		3
Engineering Topics Elective		3
Engineering Topics Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
	Credits	**17**
Spring Semester		
BSE 4126	Comprehensive Design Project	3
BSE Elective		3
Engineering Topics Elective		3
Technical Elective		3
Pathways Core Concept 2, 3, 6a, or 7		3
	Credits	**15**
	Total Credits	**128**

Biomedical Engineering & Mechanics

Our Website (http://www.beam.vt.edu)

Overview

In September 2018, the State Council of Higher Education for Virginia approved a new undergraduate degree program in Biomedical Engineering (BME) at Virginia Tech, housed within the Department of Biomedical Engineering and Mechanics (BEAM). Unlike other BME programs, Virginia Tech's program has an extensive foundation in fundamental engineering principles. This approach means students will gain a more comprehensive understanding of broader engineering practice and cross-disciplinary teambuilding. The goal is that graduating engineers can be fully integrated into diverse health care teams in order to better respond to industry needs. Graduates will be primed for placement in such fields as telemedicine, health care, data analytics, personalized medicine, medical robotics, and biomedical device design and regulatory practices, among others.

The foundation in mechanics combined with a total of 21 technical elective credits give students the flexibility to tailor their undergraduate degree within subdisciplines of the vast field of biomedical engineering. Our faculty expertise ranges from biomechanics, biomaterials, biomedical imaging, cardiovascular engineering, neuroengineering, tissue engineering, translational cancer research, and more. Additionally, our curriculum emphasizes active learning strategies and "hands-on" learning experiences to promote engaged learning and development of communication, teamwork, critical thinking, and problem-solving skills. There are also numerous opportunities to participate in design experiences throughout the curriculum, culminating in the senior capstone sequence that includes consideration of design controls and regulatory processes. The BEAM department also offers a Minor in Biomedical Engineering for undergraduate students.

The BEAM department also participates in the Accelerated Undergraduate / Graduate Degree Program, in which students meeting the requirements for the program apply for admission to the Graduate School during their junior year. This program allows students to enroll and "double-count" 12 credit hours of graduate coursework taken during their senior year of their undergraduate program at VT. The graduate program in BME is a joint program between the Virginia Tech College of Engineering and the Wake Forest School of Medicine to form the Virginia Tech-Wake Forest University School of Biomedical Engineering and Sciences (SBES) program. The SBES program is a unique multidisciplinary joint program that bridges the biomedical sciences and BME towards translational, real-world applications, offering MS, PhD and DVM/PhD at the VT campus.

Accreditation, Program Educational Objectives, and Student Learning Outcomes

The Biomedical Engineering program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Bioengineering and Biomedical and Similarly Named Engineering Programs.

Biomedical Engineering is a multidisciplinary field, using engineering principles and design concepts to advance healthcare treatment and find innovative solutions. We strive to prepare our graduates to succeed in advanced graduate or professional study, industry, and government. Within a few years after graduation, we expect our graduates to productively contribute to improving the human condition. In these activities, our alumni will attain the following **program educational objectives** within a few years following graduation:

- Develop and advance in their professional careers within industry, academia, and/or healthcare.
- Communicate and collaborate effectively across professional and disciplinary boundaries while exhibiting self-awareness of their role within the profession.
- Continually build knowledge and skills to successfully navigate the changing technology and healthcare challenges.
- Embody Ut Prosim through application of their engineering knowledge and experience in ethical service to local, national, and global communities

These program educational objectives are supported by a curriculum that seeks to have its graduates achieve the following **student learning outcomes** by the time they graduate:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

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Department Head: Stefan Duma
Undergraduate BME Program Chair: Sara Arena
N. Waldo Harrison Professor: P. VandeVord
Newport News-Tenneco Professor: T. Dingus
L. Preston Wade Professor: R.M. Queen
Harry C. Wyatt Professor: S.M. Duma
Professors: T. Dingus, S.M. Duma, R. Gourdie, S. LaConte, S.H. McKnight, J. Munson, S. Poelzing, R.M. Queen, and P. VandeVord
Associate Professors: J. Chappell, Z. Doerzaph, Y.W. Lee, M. Perez, S. Rowson, C.D. Untaroiu, E. Vlaisavljevich, and V.M. Wang
Assistant Professors: C. Collins, N. Gurari, A. Han, O. Kim, A Korneva, and M. Roberts
Collegiate Associate Professors: C. Arena and S. Arena
Collegiate Assistant Professors: A. Taylor
Instructors: K. Tate and J. Newton
Professor of Practice: A. Muelenaer and R. Stone
Affiliate Faculty: Over 150 affiliate faculty (https://beam.vt.edu/people/faculty.html)
Academic and Career Advisor: A. Sandridge

Undergraduate Course Descriptions (BMES)

BMES 2004 - Concussion Perspectives: Medical, Scientific and Societal Perspectives (3 credits)
Broad, multidisciplinary description of concussion as it relates to variety of fields including: medicine, psychology, injury biomechanics, technology, equipment design, ethics, and law. Concussion modeling, animal models, diagnosis, neurocognitive testing, and treatment. Testing and instrumentation. Research efforts, credibility and conflicts of interest. Ethical considerations in sports, medicine, and science. Legal implications.
Pathway Concept Area(s): 1A Discourse Advanced, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 2014 - Biomedical Engineering Professional Practice (1 credit)
Topics selected to foster professional development of the Biomedical Engineering (BME) student, including training for experiential learning opportunities, such as research, internships, co-ops, and design. Overview of BME specialization and research areas, career pathways, and preparation for interactions with industry, including the regulatory approval process associated with medical device development. Emphasis on teamwork, communication, employment opportunities, the development of a professional portfolio, ethical considerations, additive manufacturing, and engineering documentation using real-world examples and a design sprint/challenges.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMES 2024 - ESTEEMED Program Seminar (1 credit)
Professional development seminar series for National Institutes of Health (NIH) Enhancing Science, Technology, EnginEering, and Math Educational Diversity (ESTEEMED) program scholars. Professional development and construction of professional portfolio. Overview of safety and ethical considerations within biomedical engineering research. Development of scientific literature searching and summarizing skills. Communication skill development of written and oral content. Strategies for mentoring relationships. May be repeated 3 times with different content for a maximum of 4 credit hours. Pre: Only available to students in the ESTEEMED program.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 4 credit hours

BMES 2074 - Computational Methods in Biomedical Engineering (2 credits)
Numerical methods and software applied to biomedical engineering applications. Structured programming and problem solving within programming environment such as MATLAB. Error estimation, root finding, curve fitting, interpolation, solving linear simultaneous equations, numerical differentiation, numerical integration, and numerical solutions to ordinary differential equations.
Prerequisite(s): MATH 1226 and (ENGE 1215 or ENGE 1414)
Corequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (2 Lec, 2 Crd)

BMES 2104 - Introduction to Biomedical Engineering (3 credits)
Identification, exploration, and evaluation of real-world, complex biomedical engineering problems including safety and ethical considerations. Emphasis on critical thinking, problem solving, group skills, and communication related to the field of biomedical engineering. Literature review and experimental design in biomedical engineering research.
Prerequisite(s): (ENGE 1216 or ENGE 1414) and MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 3004 - Helmet Design: Biomechanics to Health & Social Disparities in Sports (3 credits)
Provides a multidisciplinary description of helmet design with applications to all sports. The biomechanical design parameters for helmets are presented in the broader context of health and social disparities. Through reasoning in the social sciences the class investigates how sex and gender roles have shaped sports and their individual helmet design disparities. A critical analysis of equity relative to race and healthcare is analyzed as it pertains to helmets and concussion treatments and outcomes. Demonstrate the interdisciplinary nature of helmet design and how ethical reasoning and social constructs have shaped the industry.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3024 - BME Cell Engineering Laboratory and Design (2 credits)
Principles of cell engineering, experiment design, quantitative alyses. Laboratory notebook keeping, report writing and oral presentation in a team setting. Measurement of biological molecules such as DNA, RNA, and proteins. Assessment of animal cell viability, migration, mechanics and interactions with biomaterials. Identification of cell phenotypes.
Corequisite(s): BIOL 1105, BMES 2104
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BMES 3034 - Bioinstrumentation Laboratory and Design for Living Systems (2 credits)
Principles of biomedical sensors and their usage for experimental design. Collection of biological signals using analog signal amplifiication and filters, biopotentials, digital acquisition, digital filtering and processing. Analysis of physiological signals on living systems with focus on neural, cadiovascular, respiratory, and muscular systems using a group problem solving approach. Instrumental regulation and safety considerations.
Prerequisite(s): BMES 2104 and ECE 3054
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

BMES 3114 - Needs Identification in Healthcare (3 credits)
Define open-ended problem statements related to healthcare. Immersive clinical observation and transdisciplinary medical technology innovation. Needs exploration and screening, disease state fundamentals, and evaluation of existing solutions. User-centered research planning, contextual inquiry, data documentation, stakeholder and market analysis, and regulatory and reimbursement basics.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3124 - Introduction to Biomechanics (3 credits)
Basic principles of biomechanics. Basic musculoskeletal anatomy. Application of classical mechanics to biological systems. Emphasis placed on mechanical behavior (stress and strain), structural behavior, motion, and injury tolerance of the human body. Biomechanics of medical devices and implants. Advances in safety equipment used in automotive, military, and sports applications.
Prerequisite(s): BMES 2104 and ESM 2204 and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3134 - Introduction to Biomedical Imaging (3 credits)
Introduction to major biomedical imaging modalities. Emphasis on X-rays, computerized tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), ultrasound, and optical imaging. Essential physics and imaging equations of the imaging system. Sources of noise and primary artifacts. Patient safety and clinical application.
Prerequisite(s): BMES 2104 and (MATH 2204 or MATH 2204H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3144 - Biomedical Devices (3 credits)
Design and uses of biomedical devices for diagnosis and therapy of human and animal diseases. Disease eiologies, progression, risk factors, and epidemiology. Tissue, organ, and systems dysfunction and failure and relevance to life stages (pediatric, adolescent, adult, aged). Useful characteristics of engineered materials for device fabrication, including biocompatibility. Gaps between medical needs and current medical devices.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3154 - Biosignal Processing and Classification (3 credits)
Introduction to the concepts and applications of digital signal processing and machine learning on bioinstrumentation signals from physiologic systems. Emphasis on processing techniques for electrocardiogram (ECG), electromyography (EMG), and speech signals. Apply basic machine learning algorithms for diagnostic classification of biosignals.
Prerequisite(s): BMES 2104 and (CS 1044 or CS 1054 or CS 1064 or CS 1114 or ME 2004 or AOE 2074 or ESM 2074 or BSE 3144 or BMES 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3164 - Fundamentals of Regenerative Medicine and Tissue Engineering (3 credits)
Fundamentals of cell biology, physiology, and engineering of regenerative medicine. Techniques and technologies of regenerative medicine and tissue engineering. Biomaterial selection and manufacturing techniques for regenerative medicine and tissue engineering applications. Overview of genetic and immuno- therapies. Design criteria and process from bench to clinical implementation of tissue engineering solutions. Ethical implications in regenerative medicine.
Prerequisite(s): BMES 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3184 - Problem Solving in BME (3 credits)
Computational and analytical approaches to analyzing biological systems and solving biomedical engineering problems. Problem formulation and exploration of problem-solving techniques to validate computational solutions. Self-directed inquiry and team-based approaches that use reverse engineering, user-in-mind design, and engineering software tools.
Prerequisite(s): BMES 2104 and (ESM 2074 or BMES 2074) and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3224 - Automobile Safety (3 credits)
Provides multidisciplinary analysis of automobile safety around the world. Illustration of the details about the invention of the wheel and how various cultures advanced the wheel into carts for transportation. Design process of seatbelt systems, frontal airbag and side airbag systems. Analysis of vehicle design parameters to optimize restraint systems. Analysis of the design challenges of protecting all occupants including men, women, children, elderly and pregnant occupants. Ethical analysis of the history of laws, media, and societal norms around seatbelt use and current distracted drivers using cell phones.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 3844 - Computational Neuroscience and Neural Engineering (3 credits)
Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 3844

BMES 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

BMES 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4015 - BME Senior Design and Project (3 credits)
4015: Apply biomedical engineering principles to the design of an approved project using the team approach. Develop design and communication skills. Integrate ethical, global and social issues in engineering. 4016: Apply biomedical engineering principles to develop solutions for an approved design project using a team approach. Complete a project resulting in prototype medical device, circuit, or system. Refine design and communication. Integrate ethical, global, environmental and social issues in engineering. Pre: Senior standing for 4015.
Prerequisite(s): BMES 3034 and BMES 3184
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMES 4016 - BME Senior Design and Project (3 credits)
4015: Apply biomedical engineering principles to the design of an approved project using the team approach. Develop design and communication skills. Integrate ethical, global and social issues in engineering. 4016: Apply biomedical engineering principles to develop solutions for an approved design project using a team approach. Complete a project resulting in prototype medical device, circuit, or system. Refine design and communication. Integrate ethical, global, environmental and social issues in engineering. Pre: Senior standing for 4015.
Prerequisite(s): BMES 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMES 4034 - Wearable Bioinstrumentation (3 credits)
Exploration of science, engineering, and data analytics principles behind wearable technology. Non-invasive measurement and assessment of human physiology and behavior. Data processing and analysis of non-invasive biosignals. Data privacy, protection, and ethical considerations of wearable devices.
Prerequisite(s): (CS 1044 or CS 1054 or CS 1064 or CS 1114 or ME 2004 or AOE 2074 or ESM 2074 or BSE 3144 or BMES 2074) and (STAT 3615 or STAT 3704 or STAT 4604) and (ECE 2054 or ECE 3054)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4064 - Introduction to Medical Physiology (3 credits)
An introductory to the principles of medical physiology. Designed primarily for (but not limited to), undergraduate students minoring in biomedical engineering, and other related engineering and physical sciences majors with little or no formal background in biological sciences. Basic principles and concepts of human physiology. Special emphasis on the interactions of human systems biology in their entirety rather than individual genes and pathways. Pre: Junior standing or permission of instructor.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4134 - Global, Societal, and Ethical Considerations in Biomedical Engineering (3 credits)
Overview of contemporary technological advances to improving human health. Comparison of healthcare systems, problems, and existing solutions throughout the developed and developing world. Consideration of legal and ethical issues associated with developing and implementing new medical technologies. Recognition and definition of gaps between medical needs and current methods and therapies between developed and developing countries. Conceptually design a novel technology.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4154 - Commercialization of BME Res (3 credits)
Commercialization process applied to translational research. Regulatory aspects of biomedical engineering products and technologies (e.g. devices, diagnostics, drugs, biologics). Intellectual property, technology transfer processes, clinical trial design, commercialization of university research, modeling of development costs (e.g. cash flow and revenue projections). Small business startup approaches.
Prerequisite(s): BMES 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

BMES 4234 - Mechanics of Biological Systems (3 credits)
Anatomy and physiology of biological systems such as cells, tissues, and organs. Experimental techniques for determining the mechanical behavior of biological systems. Simplified mechanics-based mathematical models of biological systems. Specific biological systems include cells, tissues, and organs of the musculoskeletal, cardiovascular, integumentary system, and reproductive systems.
Prerequisite(s): ESM 2204 and MATH 2214 and MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4234

BMES 4574 - Biomaterials (3 credits)
Materials for biomedical applications. Basic material types and properties, functional uses of materials in medical applications, and tissue response mechanisms. Integrated design issues of multicomponent material design in prosthetic devices for hard and soft tissues, orthopedics , cardiovascular, and drug delivery applications.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 4574

BMES 4614 - Probability-Based Modeling, Analysis, and Assessment (3 credits)
Uncertainty analysis of engineering data, parameters estimation, probability concepts, random variables, functions of random variables, probability-based performance functions and failure modes, risk and reliability functions, probability of failure and safety index, random sequences and stochastic processes, correlation functions and spectral densities, return period and extreme values, failure rates, performance monitoring and service life prediction.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4614

BMES 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

BMES 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMES 29844 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Biomedical Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BMES 2014	Biomedical Engineering Professional Practice	1
BMES 2074	Computational Methods in Biomedical Engineering	2
BMES 2104	Introduction to Biomedical Engineering	3
BMES 3024	BME Cell Engineering Laboratory and Design	2
BMES 3034	Bioinstrumentation Laboratory and Design for Living Systems	2
BMES 3184	Problem Solving in BME	3
BMES 4015	BME Senior Design and Project	3
BMES 4064	Introduction to Medical Physiology	3
BMES 4134	Global, Societal, and Ethical Considerations in Biomedical Engineering	3
BIOL 1105	Principles of Biology	3
ECE 3054	Electrical Theory	3
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ESM 3234	Fluid Mechanics I-Control Volume Analysis	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MSE 2034	Elements of Materials Engineering	3
STAT 3615	Biological Statistics	3
or STAT 4604	Statistical Methods for Engineers	
Subtotal		52

Additional Course Requirements		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGE 3900 Bridge Experience [1]		0
Subtotal		4
Technical Electives		
Select seven Technical Electives		21
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
BMES 4016	BME Senior Design and Project (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select one Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours. [2]		3
Subtotal		47
Total Credits		**124**

[1] Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BSBME degree. Because some of these experiences are not credit bearing, the ENGE 3900 course is used to track and assess student participation in Career Bridge and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan. Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in BMES 2014.

[2] A total of 6 hours of Pathways 2 and 6 hours of Pathways 3 courses must be completed. Only selected courses can simultaneously satisfy both Pathways 2/3 & 7 requirements. Use extra care when selecting this course.

Technical Electives

The BME degree requires 21 credits of approved technical electives, of which a minimum of 12 credits must be taken from List A. Please see the below lists for technical elective choices. A 3/4000-level course in another discipline that has significant technical content relevant to the science or application of biomedical engineering can be used as a technical elective only with prior approval.

Approved Technical Elective Lists for BME Undergraduate Students

Note: Below listed technical elective courses have pre- and/or co-requisites, be sure to consult the University Catalog or check with your advisor.

List A of Technical Electives

(minimum of 12 credits from this list)

Code	Title	Credits
BMES 3004	Helmet Design: Biomechanics to Health & Social Disparities in Sports	3
BMES 3114	Needs Identification in Healthcare	3
BMES 3124	Introduction to Biomechanics	3
BMES 3134	Introduction to Biomedical Imaging	3
BMES 3144	Biomedical Devices	3
BMES 3154	Biosignal Processing and Classification	3
BMES 3164	Fundamentals of Regenerative Medicine and Tissue Engineering	3
BMES 3224	Automobile Safety	3
BMES 3844	Computational Neuroscience and Neural Engineering	3
BMES 4034	Wearable Bioinstrumentation	3
BMES 4234	Mechanics of Biological Systems	3
BMES/MSE 4574	Biomaterials	3
BMES 4614	Probability-Based Modeling, Analysis, and Assessment	3
BMES 5024	Biomedical Engineering and Human Disease [3]	3
BMES 5044	Engineering Mathematics [3]	3
BMES 5054	Quantitative Cell Physiology [3]	3
BMES 5064	Quantitative Organ Systems Physiology [3]	3
BMES 5074	Biomedical Research Design [3]	3
BMES 5124	Advanced Musculoskeletal Biomechanics [3]	3
BMES 5164	Advanced Impact Biomechanics [3]	3
BMES 5174	Biomechanics of Crash Injury Prevention [3]	3
BMES 5184	Injury Physiology [3]	3
BMES 5204	Laboratory Techniques in Injury Prevention [3]	4
BMES 5214	Human Physical Capabilities [3]	3
BMES 5234	Advanced Vehicle Safety Systems [3]	3
BMES 5304G	Advanced Biological Transport Phenomena [3]	3
BMES 5304	Biological Transport Phenomena [3]	3
BMES 5305	Biomechanics of the Cardiovascular System [3]	3
BMES 5306	[3]	3

BMES 5314	Introduction to Regenerative Medicine [3]	3
BMES 5434	Polymeric Biomaterials [3]	3
BMES 5514	Digital Signal Processing for Mechanical Measurements [3]	3
BMES 5525	Stochastic Signals and Systems [3]	3
BMES 5534	Advanced Computational Methods and Modeling for Biomedical Applications [3]	3
BMES 5554	Imaging and Computing in Medicine [3]	3
BMES 5574	Advanced Biomaterials [3]	3
BMES 5604	Cancer Detection and Therapeutics [3]	3
BMES 5614	Multiscale Cancer Engineering [3]	3
BMES 5714	Biomedical Microdevices [3]	3
BMES 5724	Biomedical Nanoengineering [3]	3
BMES 5764	Modeling MEMS and NEMS [3]	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4204	Musculoskeletal Biomechanics	3
ESM 4224	Biodynamics and Control	3
ESM 4234	Mechanics of Biological Systems	3
ESM 4245	Mechanics of Animal Locomotion	3
ESM 4246	Mechanics of Animal Locomotion	3
ESM 4304	Hemodynamics	3
ESM 5224	Advanced Musculoskeletal Biomechanics [3]	3
ESM 5245G	Mechanics Animal Locomotion [3]	3
ESM 5246G	Mechanics Animal Locomotion [3]	3
ESM 5305	Biomechanics of the Cardiovascular System [3]	3

[3] 5000-level courses are typically restricted based on amount of total credit hours completed, GPA, and available seats after graduate student registration. Please contact the BME academic advisor regarding registering for 5000-level courses.

List B of Technical Electives

Code	Title	Credits
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BMES 4154	Commercialization of BME Res	3
BMES 5154G	Advanced Commercialization of Biomedical Engineering Research [3]	3
BMVS 4054	Laboratory Animal Management	3
BMVS 4074	Pharmacology	3
CHEM 4554	Drug Chemistry	3
ESM 3054	Mechanical Behavior of Materials	3
ESM 3334	Fluid Mechanics II-Differential Analysis	3
ESM 4024	Advanced Mechanical Behavior of Materials	3
ESM 4044	Mechanics of Composite Materials	3
HNFE 3634	Epidemiologic Concepts of Health and Disease	3
HNFE 3824	Kinesiology	3
MATH 3214	Calculus of Several Variables	3
MATH 4234	Elementary Complex Analysis	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MSE 4164	Principles of Materials Corrosion	3
MSE 4304	Metals and Alloys	3
MSE 4584	Biomimetic Materials	3
MSE 4614	Nanomaterials	3
NEUR 3044	Cellular and Molecular Neuroscience	3
PHYS 3324	Modern Physics	4
PHYS 3405	Intermediate Electricity and Magnetism	3
PHYS 3406	Intermediate Electricity and Magnetism	3
PHYS 4455	Introduction to Quantum Mechanics	3
PHYS 4456	Introduction to Quantum Mechanics	3
PHYS 4504	Introduction to Nuclear and Particle Physics	3
PHYS 4574	Nanotechnology	3
PHYS 4614	Optics	3
PHYS 4714	Introduction to Biophysics	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The BEAM Department fully supports this policy. Specific expectations for satisfactory progress for Biomedical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- After having completed 72 credit hours (including transfer, advanced placement, advanced standing, and credit by examination) must have:
  - Maintain an in-major GPA (in-major GPA is calculated using all courses taught under the BMES designator) of 2.0 or better
- Complete a minimum of 12 credits that apply toward the BME degree per academic year (including summer and winter sessions).

Graduation Requirements

Each student must complete at least 124 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. All BMES prefix courses count towards the in-major GPA.

Acceptable Substitutions

1. (MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context) may be substituted for (MATH 2114 Introduction to Linear Algebra+MATH 2204 Introduction to Multivariable Calculus+MATH 2214 Introduction to Differential Equations)
2. BMES 3900 Bridge Experience may be substituted for ENGE 3900 Bridge Experience

Foreign Language Requirements

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering	2
Pathways 2 or 3		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
	Credits	**16**
Second Year		
Fall Semester		
BIOL 1105	Principles of Biology	3
BMES 2014	Biomedical Engineering Professional Practice	1
ESM 2104	Statics	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2214	Introduction to Differential Equations	3
PHYS 2306	Foundations of Physics	4
	Credits	**17**
Spring Semester		
BMES 2104	Introduction to Biomedical Engineering	3
ECE 3054	Electrical Theory	3
ESM 2304	Dynamics	3
BMES 2074	Computational Methods in Biomedical Engineering	2
MSE 2034	Elements of Materials Engineering	3
	Credits	**14**
Third Year		
Fall Semester		
BMES 3024	BME Cell Engineering Laboratory and Design	2
ESM 3234	Fluid Mechanics I-Control Volume Analysis	3
ESM 2204	Mechanics of Deformable Bodies	3
STAT 3615 or STAT 4604	Biological Statistics or Statistical Methods for Engineers	3
BMES 4064	Introduction to Medical Physiology	3
ENGE 3900 Bridge Experience [1]		0
	Credits	**14**
Spring Semester		
BMES 3034	Bioinstrumentation Laboratory and Design for Living Systems	2
BMES 3184	Problem Solving in BME	3
Technical Elective		3
Technical Elective		3
Pathways 2 or 3		3
	Credits	**14**
Fourth Year		
Fall Semester		
BMES 4015	BME Senior Design and Project	3
BMES 4134	Global, Societal, and Ethical Considerations in Biomedical Engineering	3
Technical Elective		3
Technical Elective		3
Pathways 2 or 3		3
Pathways 6a		3
	Credits	**18**
Spring Semester		
BMES 4016	BME Senior Design and Project	3
Technical Elective		3
Technical Elective		3
Technical Elective		3
Pathways 2/7 or 3/7		3
	Credits	**15**
	Total Credits	**124**

[1] Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BSBME degree. Because some of these experiences are not credit bearing, the ENGE 3900 course is used to track and assess student participation in Career Bridge and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan. Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in BMES 2014.

Building Construction

Our Website (http://www.bc.vt.edu)

Overview

The Myers-Lawson School of Construction offers students in the College of Engineering a Bachelor of Science in Building Construction (BC). The curriculum focuses on the business and process of making, managing, assembling, and the performance of buildings, including their operations, finance, energy use, and sustainability. The BC degree options are designed to better equip construction industry professionals with the necessary tools for excellence in all phases of the built environment. The degree incorporates business, management, science, and efficiency at all levels; from planning, finance, design, estimating, procurement, scheduling, construction, and maintaining buildings necessary to the way our world will be built and lived in during the future.

Throughout their studies, students will explore all phases of a building construction project, from initial planning to final execution. Core courses cover construction means and methods, materials, cost estimating and scheduling, new technologies, project delivery, and cost and risk management. They will learn how to manage construction projects, including organization, scheduling, budgeting, and implementation. Integrative elements of leadership, professional and presentation skills, entrepreneurship, and best practice management principles are included to prepare graduates to work effectively as part of a construction team. A capstone course is a requirement for all students, providing a culminating experience to apply the concepts learned.

The BC program is accredited by the American Council for Construction Education (ACCE). Upon completion of the four-year, 122-credit-hour curriculum, students receive a Bachelor of Science in Building Construction.

- Building Construction Major (p. 805)

Head: G. Reichard
Assistant Head: R. Ryan

Graduate Program Director: T. Bulbul

Preston and Catharine White Director: B Kleiner[1]
Beliveau Professor: A.P. McCoy
William E. Jamerson Professor: W.Y. Thabet
Professor: G. Reichard
Associate Professors: A. Akanmu, T. Bulbul, A.R. Pearce[2], Roofigari-Esfahan, X. and L. Zhang
Assistant Professors: P. Agee, N. Gao, A. Shojaei, and R. Zhang
Collegiate Associate Professors: J. Iorio
Assistant Professor of Practice: J. Bluey, L. Lally, M. Oliver, and X. Lv
Adjunct Faculty: C. Bell, R. Clark, W. Thumm
Professors Emeritus: Y. Beliveau
Academic Advisors: G. Kinder, S. Norwood[3]

Footnotes:

[1]Construction Industry Institute Distinguished Professor

[2]Alumni Award for Outreach Excellence

[3]Provost's Award for Excellence in Advising

Undergraduate Course Descriptions (BC)

BC 1014 - Building A Strong Foundation for Success (2 credits)
Exploration of career options within the built environment and construction industry. Professional development, digital literacy, which will include creation of media and "personal brand" identity. Exploration of ideas from multiple viewpoints and perspectives. Oral, written, and visual presentation of ideas such as resume development. Introduction to ethical considerations. Reflection on "Self-as-Learner." Critical-Thinking skills as they apply to construction projects. Development of group roles as they apply to construction projects. Identification of universities resources, policies, procedures, academic and social engagement opportunities.
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 1114 - Introduction to Building Construction (3 credits)
Introduction to construction with understanding of different market sectors, specializations, career path opportunities, industry stakeholders, and processes. Comprehension of quality assurance, control, project delivery systems, basic estimating, and scheduling. Application of communication skills to professional settings and use of basic calculations to solve construction math problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 1124 - Construction Documents and Safety (2 credits)
Role of construction drawings and specifications. Interpretation of construction documents and creation of basic project documentation. Health, safety, and environmental hazards encountered in the construction industry. Design Lab Studio (1H, 2L, 2C)
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

BC 1214 - Introduction to Building Construction I (3 credits)
Introduction to construction with an overview of construction drawings and specifications, construction terminology, building codes and building systems, cost estimating and bidding, construction management processes, construction documents, load paths and foundations, construction health and safety, and hands-on experiential learning through lab exercises. Strategic career success factors and introduction to ethical decisions in construction management.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 1224 - Introduction to Building Construction II (3 credits)
Overview of the important areas of contracting and the workings of the construction industry. Application of construction management theory, processes, and terminology including, definable building systems, building code interpretations, the reading and preparing of basic construction drawings and integrating construction details and project specifications to derive safe construction means and methods, equipment section, cost estimates and time schedules.
Prerequisite(s): BC 1214 or BC 1114
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2004 - Construction Surveying (1 credit)
Surveying in context of the construction process, basic surveying methods, equipment, emerging technologies, topographic surveying, and application to construction layout.
Prerequisite(s): BC 1124
Instructional Contact Hours: (1 Lec, 1 Crd)

BC 2014 - Construction Principles I (3 credits)
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2024 - Construction Principles II (3 credits)
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression.
Prerequisite(s): BC 2014
Corequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2044 - Construction Materials (3 credits)
Introduction to the life cycle, properties, behaviors, and sustainability impacts of common construction materials including wood, insulation, asphalt, ferrous and nonferrous metals, aggregate, concrete, masonry, glass, and plastics. Theory of materials including material properties; behavior under physical, thermal, and environmental loads; and interfaces between dissimilar materials. Methods and criteria for material comparison and selection for sustainable construction. Preparation of professional written reports as a team and individually; Project management for materials selection/application.
Corequisite(s): BC 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2064 - Integrated Construction I (3 credits)
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project.
Prerequisite(s): BC 2014 and BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2104 - Building Effective Construction Teams (3 credits)
Introduction to leadership behavior styles and their impact on construction management team performance, including analysis of how ethical behavior and individual strengths support positive relationship-building. Development of management strategies to maximize positive conflict outcomes through trust-building between construction project stakeholders. Identification of the role that implicit bias plays in decision-making within diverse project teams. Development of presentation skills for a construction audience.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2114 - Information Technology in Design and Construction (3 credits)
Building delivery and project management improvements through the use of information technology (IT) are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts that integrate design and construction. Use BIM/VDC tools for graphical presentations, databases, and spreadsheets.
Prerequisite(s): BC 1224 or CEM 2104 or BC 1124
Corequisite(s): BC 2014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2134 - Construction Data Analysis (2 credits)
Identification and use of various types and sources of construction market data and the tools for analyzing construction data to support managerial decision making. Different forms of applying mathematics to the construction market for better productivity and processes across the construction industry. Develop insights to inform management and investment decisions. Use of cost-benefit analysis as applied to construction management in determining feasibility of projects.
Prerequisite(s): MATH 1025 or MATH 1225
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 2214 - Why Buildings Stand Up (3 credits)
Overview of fundamental principles explaining why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Calculation of shear, bending moments, deflections in beams, and buckling. Discussion of ethical impacts on user safety and hazard avoidance, in project design and construction methods, materials, etc. Explores different types of soil composition and their strength properties.
Prerequisite(s): (BC 1224 or BC 1124) and (MATH 1025 or MATH 1225)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2354 - Residential Construction Technologies (3 credits)
Identify and evaluate conventional construction materials, methods, building systems, and products to less-familiar, innovative technological alternatives for a specific residential construction project. Compare innovative technological alternatives with material and cost estimates. Overview of conventional materials, equipment, designs, and processes in residential construction. Investigate recent literature on emerging technologies to determine best practices. Strengthen understanding of the primary building systems in residential construction applications.
Prerequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 3014 - Building Physics and Environmental Systems (3 credits)
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems.
Prerequisite(s): PHYS 2205 and PHYS 2215 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3064 - Integrated Construction II (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project.
Prerequisite(s): (BC 2064 or CEM 2104) and (PHYS 2205 and PHYS 2215 or PHYS 2305)
Corequisite(s): BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3114 - Building Systems Technology (3 credits)
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads.
Prerequisite(s): BC 2024 and (PHYS 2305 or PHYS 2205 and PHYS 2215) or (CEM 2104 and PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 3134

BC 3954 - Study Abroad (1-19 credits)
Study abroad in Spain.
Instructional Contact Hours: Variable credit course

BC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4024 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4014

BC 4064 - Integrated Construction III (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4114 - Building Information Modeling in Design and Construction (3 credits)
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming.
Prerequisite(s): BC 2114 or (ENGE 1215 and ENGE 1216)
Corequisite(s): CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4124 - Digital Construction & Manufacturing (3 credits)
Explore working principles, design projects, & experiment with construction digital information modeling, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Fundamentals of digital prototyping. Analysis of the industry tools such as 3D scanners, 3D printers, CNC manufacturing techniques, and others, used to provide familiarity with technologies & provide understanding of their benefits & limitations.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4164 - Production Planning and Process Design for Construction (3 credits)
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4264 - Fundamentals of Construction Management (6 credits)
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing.
Instructional Contact Hours: (6 Lec, 6 Crd)

BC 4314 - Building Performance and Energy Management (3 credits)
Fundamentals of building performance mandates for the built environment. Practical means and methods for evaluating building performance metrics within integrated design including acoustic performance, visual performance, and indoor air quality and management. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle.
Prerequisite(s): BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4324 - Innovation in Residential Construction (3 credits)
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4334 - Sustainable Building Performance Management (3 credits)
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning.
Prerequisite(s): BC 3064 and BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4364 - Lifecycle BIM for Facility Management (3 credits)
BIM (Building Information Modeling) concepts and tools that are critical for facility operation and maintenance. Identifying, capturing, analyzing, exporting and exchanging facility lifecycle data. Spreadsheet-based and BIM based facility management platforms. Case studies and real-life application for understanding mechanical, electrical, and plumbing systems from an owner or facility manager perspective. Workflow processes for data exchange.
Prerequisite(s): BC 2114 and BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4374 - Residential Housing and Land Development (3 credits)
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4434 - Construction Practice I (3 credits)
Explores advanced business and management practices and applications to vertical construction projects. Topics include scope, planning and scheduling, assemblies estimating, cash flow controls. Creation of work breakdown structure, application of concepts of assemblies estimating and general conditions to interpret insurance and contract requires along with digital construction practices.
Prerequisite(s): BC 3064 and BC 3114 and BC 3134
Corequisite(s): BC 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4444 - Construction Practice II (4 credits)
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals.
Prerequisite(s): BC 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BC 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

BC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Building Construction Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BC 1114	Introduction to Building Construction	3
BC 2004	Construction Surveying	1
BC 2014	Construction Principles I	3
BC 2024	Construction Principles II	3
BC 2044	Construction Materials	3
BC 2064	Integrated Construction I	3
BC 3064	Integrated Construction II	3
BC 3114	Building Systems Technology	3
BC 4064	Integrated Construction III	3
BC 4434	Construction Practice I	3
BC 4444	Construction Practice II	4
Subtotal		32
Major Requirements		
BC 1124	Construction Documents and Safety	2
BC 2104	Building Effective Construction Teams	3
BC 2114	Information Technology in Design and Construction	3
BC 2134	Construction Data Analysis	2
BC 3134	Temporary Structures in Construction	3
BC 4164	Production Planning and Process Design for Construction	3
CEM 3084	Construction Economy	3
FIN 3054	Legal and Ethical Environment of Business	3
MGT 3304	Management Theory and Leadership Practice	3
Subtotal		25
Elective Courses		
Select 6 credit hours of technical electives.		6
Select 6 credit hours of Business & Management Electives.		6
Select 9 credit hours of Track Core Electives.		9
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015 or ENGL 1105	Communication Skills (1F) First-Year Writing	3
COMM 1016 or ENGL 1106	Communication Skills (1F) First-Year Writing	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select three credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) that also satisfies Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005 or AAEC 1005	Principles of Economics Economics of the Food and Fiber System	3
ECON 2006 or AAEC 1006	Principles of Economics Economics of the Food and Fiber System	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
GEOS 1004 & GEOS 1104	Earth Science: Our Past, Present, and Future and Introduction to Earth Sciences Laboratory	4
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory	4
Pathways Concept 5 - Quantitative and Computational Thinking		
ACIS 1004	Accounting Foundations (5F)	3
BC 2214	Why Buildings Stand Up (5A)	3
MATH 1025	Elementary Calculus (5F)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits of Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3

Select three credits of Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select a course from Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) that also satisifes #PATHWAY-2. [4]	
Subtotal	44
Total Credits	**122**

Electives

Business and Management Electives

Code	Title	Credits
Select six credits from the following:		
AAEC 3324	Environment and Sustainable Development Economics	3
AAEC 3454	Small Business Management and Entrepreneurship	3
ACIS 2116	Principles of Accounting	3
AS 3215	Air Force Management and Leadership	3
AS 3216	Air Force Management and Leadership	3
CEM 4024	Construction Law and Contract Administration	3
ISE 4004	Theory of Organization	3
MGT 2064	Foundations of Entrepreneurship	3
MGT 2354	Teams, Leadership, and Business: Cultivating Excellence	3
MGT 3064	Cornerstones of Entrepreneurship and Innovation	3
MKTG 3104	Marketing Management	3
MKTG 4734	Real Estate Marketing	3
MN 4005	Leadership and Management/Ethics	3
MN 4006	Leadership and Management/Ethics	3
MS 4005	Military Science IV, Army Reserve Officer Training Corps	4
MS 4006	Military Science IV, Army Reserve Officer Training Corps	4
PM 4684	Leasing Commercial Properties	3
REAL 2004	Principles of Real Estate	3
REAL 4754	Real Estate Law	3

Track Core Electives

Code	Title	Credits
Select one of the four tracks below:		
Emergent Technologies for Construction, Housing and Development		
BC 2354	Residential Construction Technologies	3
BC 4324	Innovation in Residential Construction	3
BC 4374	Residential Housing and Land Development	3
Information Systems in Built Environment		
BC 4114	Building Information Modeling in Design and Construction	3
BC 4124	Digital Construction and Manufacturing	3
BC 4364	Lifecycle BIM for Facility Management	3
Sustainable Building Performance		
BC 3014	Building Physics and Environmental Systems	3
BC 4314	Building Performance and Energy Management	3
BC 4334	Sustainable Building Performance Management	3
Directed Elective		
Students pursuing double majors may use courses from their other major for directed electices to build their own track as long as the courses are not building construction major requirements. Students must have a plan of study signed by the department head or assistant director of student affairs comprised of courses to form a focues area of study for this track.		

Technical Electives

Code	Title	Credits
Select six credits of the following. A minimum of 3 of the credits must be 3000-4000.		
BC Electives		
Any BC 2000-5000 level course or special study that does not fulfill a construction major requirement. This includes BC track courses from outside their designated track selection provising capacity. These courses cannot be double-counted for both track and technical electives.		
BC Variable Credit		
BC 4754	Internship	1-3
BC 4974	Independent Study	1-19
BC 4994	Undergraduate Research	1-19
CEM		
CEM 2714	Construction Safety Systems	3
CEM 2824	Construction Site Analysis	3
CEM 3024	Construction Estimating and Scheduling	3
CEM 3154	Smart Construction	3
CEM 3064	Intro to Lean Construction	3
CEM 3074	Global Design and Construction for Sustainable Development	3
CEM 3164	Construction Health and Safety	3
CEM 3714	Controlling Construction Safety Hazards	3
CEM 4624	Construction Robotics and Automation	3
CEM 4634	Data Analysis and Visualization for Construction and Facilities Management	3
CEM 4714	Construction Safety Culture	3
CEM 4724	Construction Industry Futures: Safety, Health, and Wellness	3
REAL		
REAL 3034	Real Estate Market Analysis	3
REAL 3044	Financing Real Estate Projects	3
Others		
BC 4024	Estimating, Production, and Cost Engineering	3
CS 1014	Introduction to Computational Thinking	3
SBIO 2314	Building Information Modeling for Wood-Based Construction	3
SBIO 3324	Green Building Systems	3
VT Corp of Cadets Academic Offerings		
MGT 3935 & MGT 3936	Advanced Professional Development for Cadets and Advanced Professional Development for Cadets	4
MGT 3945 & MGT 3946	Cadet Organizational Leadership and Cadet Organizational Leadership	2

MGT 4935 & MGT 4936	Cadet Citizen Leader Practicum and Cadet Citizen Leader Practicum	4
MGT 4945 & MGT 4946	Executive Leadership for Cadets and Executive Leadership for Cadets	2

Students enrolled in a minor may use 6 credits of their minor requirements as technical electives with 3 of those being 3000-4000 level.

Satisfactory Progress Toward a Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress toward the completion of their degrees. The Myers-Lawson School of Construction fully supports this policy. Specific expectations for satisfactory progress for BC majors are as follows:

- Each student must meet the minimum university-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog. Overall GPA required to graduate is 2.00.
- All students must be registered in a least one required BC/CEM course each semester unless BC core course requirements are met.
- Students may not repeat any course(s) more than 3 times, including attempts that end in a course withdrawal.

A student who does not meet the requirements will be notified that they have one term of enrollment to rectify any deficiencies. Failure to do so within one term of enrollment will result in the student being required to transfer out of the major.

In-Major GPA

Consists of all courses under the BC and CEM designation.

Graduation Requirements

Students must pass all required courses with an overall GPA of 2.0.

Acceptable Substitutions

1. REAL 2034 Real Estate Data Analysis (3 cr) may be substituted for BC 2134 Construction Data Analysis (2 cr)
2. STAT 2004 Introductory Statistics (3 cr) may be substituted for BC 2134 Construction Data Analysis (2 cr)
3. ESM 2104 Statics (3 cr) may be substituted for BC 2214 (3 cr) but the student is required to have another pathway 5a to fulfill pathway 5 requirement
4. PHYS 2305 Foundations of Physics (4 cr) may be substituted for PHYS 2205 General Physics (3) + PHYS 2215 General Physics Lab (1)
5. MATH 1225 Calculus I (4 cr) may be substituted for MATH 1025 Elementary Calculus (3 cr)
6. ACIS 2115 (3 cr) may be substituted for ACIS 1004 (3 cr) but the student is required to have another pathway 5 (either foundational or advanced) to fulfill pathway 5 requirement.
7. ISE 2014 Engineering Economy (2 cr) may be substituted for CEM 3084 Construction Economy (3 cr) but the student must still have 122 credits to meet graduation requirements

Foreign Language Requirements

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language.College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
BC 1114	Introduction to Building Construction	3
COMM 1015 or ENGL 1105	Communication Skills or First-Year Writing	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
Pathways Concept 2 - Critical Thinking in the Humanities		3
	Credits	**15**
Spring Semester		
BC 1124	Construction Documents and Safety	2
MATH 1025	Elementary Calculus	3
GEOS 1104	Introduction to Earth Sciences Laboratory	1
COMM 1016 or ENGL 1106	Communication Skills or First-Year Writing	3
ACIS 1004	Accounting Foundations	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) & 7		3
	Credits	**15**
Second Year		
Fall Semester		
BC 2004	Construction Surveying (New course)	1
BC 2114	Information Technology in Design and Construction	3
BC 2014	Construction Principles I	3
PHYS 2205	General Physics	3
PHYS 2215	General Physics Laboratory	1
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
BC 2134	Construction Data Analysis	2
	Credits	**16**
Spring Semester		
BC 2024	Construction Principles II	3
BC 2064	Integrated Construction I	3
BC 2214	Why Buildings Stand Up	3
BC 2104	Building Effective Construction Teams	3
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
	Credits	**15**
Third Year		
Fall Semester		
BC 3114	Building Systems Technology	3
BC 3064	Integrated Construction II	3
BC 2044	Construction Materials	3
CEM 3084	Construction Economy	3
FIN 3054	Legal and Ethical Environment of Business	3
	Credits	**15**
Spring Semester		
BC 3134	Temporary Structures in Construction	3
Business & Management Elective		3
ENGL 3764	Technical Writing	3
Track Elective		3
Technical Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
BC 4064	Integrated Construction III	3
BC 4434	Construction Practice I	3

BC 4164	Production Planning and Process Design for Construction	3
MGT 3304	Management Theory and Leadership Practice	3
Track Elective		3
	Credits	**15**
Spring Semester		
BC 4444	Construction Practice II	4
Business & Management Elective		3
Technical Electives		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Track Elective		3
	Credits	**16**
	Total Credits	**122**

Chemical Engineering

Our Website (http://www.che.vt.edu)

Overview

Skillful and creative applications of the principles of chemistry, biochemistry, biology, mathematics, and physics are needed to solve the problems now confronting society. Whether these problems involve energy, food, health, materials or environmental quality, the modern chemical engineer is the professional concerned with finding economically and socially acceptable solutions. The program includes specific tracks relating to energy and climate solutions, data analytics in the chemical engineering domain, and human health. The program prepares graduates for employment in a great variety of industries including specialty chemicals, petroleum, pharmaceutics, paper, fibers, plastics, food, electronics, consumer products, and environmental remediation and lays a strong foundation for those who choose to pursue higher education, whether in chemical engineering or other disciplines such as business, medicine, or law. Students may customize their academic program around an industry of interest by judiciously selecting electives. Courses in chemistry, polymers, biotechnology, marketing, and green engineering are common choices.

Accreditation, Program Educational Objectives, and Student Learning Outcomes

The B.S. degree in Chemical Engineering at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Chemical, Biochemical, Biomolecular and Similarly Named Engineering Programs.

The **program educational objectives** are that within five years of completing their BS degrees, graduates will be successful in a variety of professional careers, including those outside of traditional chemical engineering fields as evidenced by one or more of the following achievements:

- Sustaining a career as a problem solver in engineering or other fields that require analytical skills.
- Professional advancement in positions of increasing leadership and/or responsibility.
- Attainment of an advanced degree or advanced certification in engineering, science, business, law, medicine, or education.
- Bettering society and promoting diversity, equity, and inclusion through professional or personal service.

The **student learning outcomes** are that upon completion of the BS degree in Chemical Engineering, graduates will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum

The curriculum has been developed to meet the department goal and the objectives for the graduates. The curriculum is demanding and a GPA of at least 3.0 is recommended for transfer into the program at the sophomore level. An average GPA of at least 2.00 in all CHE courses attempted (except CHE 4144 Business and Marketing Strategies for the Process Industries) is required for continued enrollment in the department. The department has specific grade policies for continuation in the program and for graduation. For further information on these policies, please contact the department.

The chemical engineering curriculum integrates studies in thermodynamics, fluid mechanics, heat transfer, mass transfer, process control, reaction kinetics, plant and process design, verbal and written communications, and reaction kinetics, along with professional ethics and environmental awareness. Throughout this curriculum students learn the fundamentals of chemical processing equipment design and operation. In addition, students gain hands-on experience with the equipment during the summer Unit Operations Laboratory. The experience culminates in participation in either a national senior-level design contest or a design project with a local industrial mentor. The laboratory and the senior design courses are recognized as two of the high points in the undergraduate program. The computer is a necessary tool in all the courses and the same software used in industry is used in the design courses.

In addition to the basic undergraduate program outlined here, more sophisticated and specialized programs leading to the M.S. and Ph.D. in chemical engineering also are offered (see Graduate Catalog (https://catalog.vt.edu/graduate/)).

The department participates in the Cooperative Education Program whereby qualified students may alternate periods of study with periods of professional employment. Students who plan to co-op should

consult with their academic advisor to plan their academic progress appropriately.

Degree Requirements

The following are special Tracks of study that students can pursue through judicious selection of technical and chemical engineering electives. Lists of approved courses for these tracks are available in the Department of Chemical Engineering.

- Climate and Energy Solution
- Computational and Data Sciences
- Healthcare Technologies

As part of **progress toward a degree**, students must maintain an in-major GPA of 2.0 or above (not including CHE 4144 Business and Marketing Strategies for the Process Industries). If the in-major GPA drops below 2.0 at any time, students will be placed on departmental probation. Students cannot remain on departmental probation for more than two consecutive semesters. In the case that a student has not achieved an in major 2.0 or better after two semesters, the student must transfer out of the department, is prohibited from registering for CHE courses for at least one semester and, after that, only with permission of Chemical Engineering department head. All CHE credits (except CHE 4144 Business and Marketing Strategies for the Process Industries) are used to calculate in-major GPA.

For **additional information** about the Chemical Engineering curriculum, please contact Dr. Goldstein.

- Chemical Engineering Major (p. 812)

Head: S.P. Wrenn
Alumni Distinguished Professor and Frank C. Vilbrandt Professor: Y.A. Liu
Robert E. Hord Jr. Professor: P. Rajagopalan
Fred W. Bull Professor: C. Lu
Professors: L.E.K. Achenie, R.M. Davis, W.A. Ducker, A.M. Karim, and E. Kiran
Associate Professors: M Bortner, S. Deshmukh, A.S. Goldstein, S.M. Khatib, S.M. Martin[5], R. Tong, H. Xin, and A.R. Whittington
Assistant Professor: S. Samaji
Professor of Practice: C. McDowell
Adjunct Professors: R. Colberg, E.H. Cwirko, R. Eisinger, C. McDowell, and B. McSheehy
Emeritus Professors: D.F. Cox and S.T. Oyama
Alexander F. Giacco Professor Emeritus: D.G. Baird

Footnotes:

1 Award for Excellence in Undergraduate Advising
2 Academy of Teaching Excellence inductee
3 Wine Award recipient
4 Sporn Award recipient
5 Alumni Award for Extension Excellence
6 Alumni Award for Research Excellence
7 Alumni Award for Teaching Excellence
8 Academy of Faculty Service
9 Commonwealth of Virginia Outstanding Faculty Award
10 Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (CHE)

CHE 2004 - Chemical Engineering Sophomore Seminar (1 credit)
Career opportunities and current topics of interest in the Chemical Engineering profession.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHE 2114 - Mass and Energy Balances (3 credits)
Stoichiometric and composition relationships, behavior of gases, vapor pressures, solubility, mass balances, recycling operations, energy balances, first law of thermodynamics, thermophysics, thermochemistry, fuels and combustion, application to chemical operations.
Prerequisite(s): MATH 1226 and (CHEM 1036 or CHEM 1036H or CHEM 1056 or CHEM 1056H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 2164 - Chemical Engineering Thermodynamics (3 credits)
First and Second Laws, properties of fluids, properties of homogeneous mixtures; phase equilibria, chemical-reaction equilibria. Grade of C- or better required in prerequisite CHE 2114.
Prerequisite(s): CHE 2114 and MATH 2204 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 3015 - Process Measurement & Control (3 credits)
3015: Common process measurements; applications to theory and practice of automatic control of chemical processes; 3016: Design and laboratory practice underlying the automatic computer control of chemical processes.
Prerequisite(s): MATH 2214 and CHE 3114
Corequisite(s): 3124, (3184 or 3185), (3044 or 3154) for 3015
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3044 - Heat Transfer (2 credits)
One and two dimensional conduction, convection, and diffusion of thermal energy; heat transfer rates, steady state and unsteady state conduction, convection; design of heat exchangers; forced and free convection boiling and condensation.
Prerequisite(s): CHE 2164 and CHE 3114 and MATH 4564
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3114 - Fluid Transport (3 credits)
Fluid statics, surface tension, fluid dynamics, Newtons Law of viscosity, momentum transport, laminar and turbulent flow, velocity profiles, flow in pipes, flow around objects, non-Newtonian fluids, design of piping systems, pumps and mixing.
Prerequisite(s): CHE 2114 and PHYS 2305 and MATH 2204
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3124 - Chemical Engineering Simulations and Process Modeling (3 credits)
Development of strategies to pose and numerically solve sets of algebraic and differential equations that describe chemical engineering systems and processes. Iterative root finding and optimization approaches to solving non-linear equations, analyze data, and determine best-fit model parameters. Numerical strategies to integrate and differentiate models and data. Approaches to solve ordinary and partial differential equations that describe reaction kinetics, process control, and transport of momentum, heat and mass. Algorithm development, coding, and graphical representation of solutions. (3H,3C)
Prerequisite(s): CHE 2114 and MATH 2214
Corequisite(s): CHE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3134 - Separation Processes (3 credits)
Binary separations and multicomponent separations, distillation, batch distillation, extraction, absorption, McCabe-Thiele and Ponchon Savaret methods, short cut methods, design of plate columns, plate and column efficiencies.
Prerequisite(s): CHE 2114 and MATH 2204 and PHYS 2306
Corequisite(s): CHE 2164 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3144 - Mass Transfer (3 credits)
Multidimensional molecular diffusion and convection of single and multi-component systems; mass transfer rates; steady state, quasi-steady state and transient mass transfer; effect of reactions on mass transfer; convective mass transfer coefficients; design of stage and continuous gas/liquid contractors, membrane, liquid-liquid and liquid-solid separation processes, artificial kidney and drug delivery systems.
Prerequisite(s): CHE 3114 and CHE 2164 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3154 - Heat Transfer Analysis (3 credits)
Principles of conduction, convection, and radiation of thermal energy through one or more phases; analytical and numerical methods for modeling multi-dimensional and unsteady-state conduction; analysis of forced and free convection in conduits and around submerged bodies; design of heat exchangers; radiative heat transfer; boiling and condensation.
Prerequisite(s): CHE 2164 and CHE 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 3185 - Chemical Reactor Analysis and Design (2 credits)
Introduction to mathematical frameworks for analysis and modeling of chemical reactions within different reactor configurations. 3185: Reaction equilibria, power-law rate expressions, Arrhenius law, rate constants, analysis of kinetic data, design of single and multiple isothermal reactors. 3186: Reaction mechanisms, multiple reactions, selectivity, non-isothermal reactors, catalytic reactions and design of catalytic reactors.
Prerequisite(s): CHE 2114 and (MATH 2214 or MATH 2214H)
Corequisite(s): CHE 2164, CHE 3114
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3186 - Chemical Reactor Analysis and Design (2 credits)
Introduction to mathematical frameworks for analysis and modeling of chemical reactions within different reactor configurations. 3185: Reaction equilibria, power-law rate expressions, Arrhenius law, rate constants, analysis of kinetic data, design of single and multiple isothermal reactors. 3186: Reaction mechanisms, multiple reactions, selectivity, non-isothermal reactors, catalytic reactions and design of catalytic reactors.
Prerequisite(s): CHE 3185 and CHE 3114 and CHE 3144 and (CHE 3044 or CHE 3154)
Instructional Contact Hours: (2 Lec, 2 Crd)

CHE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4014 - Chemical Engineering Laboratory (4 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. Applications include fluid flow, mixing, filtration, and distillation, process control, heat transfer, mass transfer, and chemical reaction kinetics. Consideration of ethical choices in engineering practice and societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 2164 and CHE 3015 and CHE 3114 and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3044 or CHE 3154) and CHE 3185 and ENGL 3764
Instructional Contact Hours: (12 Lab, 4 Crd)

CHE 4015 - Chemical Engineering Unit Operations Laboratory (2 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. 4015: Applications include fluid flow, mixing, filtration, distillation, and chemical reaction kinetics. Consideration of ethical choices in engineering practice. 4016: Applications in process control, heat transfer, mass transfer, and catalysis. Consideration of the societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 2164 and CHE 3114 and CHE 3124 and CHE 3134 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (6 Lab, 2 Crd)

CHE 4016 - Chemical Engineering Unit Operations Laboratory (2 credits)
Practical experience in the planning of experimentation, gathering of experimental data, interpretation of data, and the preparation of written and oral reports. Use of small-scale processing equipment, automatic control, and data acquisition. Emphasis on teamwork, safety, engineering judgment, and professional behavior. 4015: Applications include fluid flow, mixing, filtration, distillation, and chemical reaction kinetics. Consideration of ethical choices in engineering practice. 4016: Applications in process control, heat transfer, mass transfer, and catalysis. Consideration of the societal impacts of engineering solutions. In-major GPA of 2.0 or better.
Prerequisite(s): CHE 3015 and (CHE 3044 or CHE 3154) and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (6 Lab, 2 Crd)

CHE 4024 - Unit Operations and Scale-Up (1 credit)
Research of a chemical process unit, design of experiments, analysis and interpretation of experimental data, and scale-up of the unit to meet specific objectives. Teamwork, oral communication, and appropriate use of published information. Consideration of safety, and the societal and environmental impacts of an engineering design. Pre: In-major GPA of 2.0 or better is required.
Prerequisite(s): CHE 3015 and CHE 3044 and CHE 3124 and CHE 3134 and CHE 3144 and CHE 3184 and ENGL 3764
Instructional Contact Hours: (1 Lec, 1 Crd)

CHE 4104 - Process Materials (3 credits)
Basics of materials science as it relates to the interest of the chemical engineer. The course emphasizes the three fundamental areas of material science being polymer materials, metallics, and ceramic/inorganic glasses. The general molecular structure property - application behavior of each area will be presented but with a focus when possible on topics related to the field of chemical engineering.
Prerequisite(s): CHE 2164 and (CHEM 2535 or CHEM 2565)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4114 - Energy and Climate Change Solutions (3 credits)
Fundamentals of energy production technologies, alternative and renewable energy sources, electrochemical energy storage, direct carbon capture technologies, negative emissions technologies, and chemical process that use CO2 as a feedstock. Fundamentals of water purification technologies, the water cycle, and the impact of climate change on water resources and demands. Discussion of carbon and water economics, and how geographical, societal, and environmental factors affect energy and water management policies. Techno-economic analysis of solutions based on chemical technologies, and the communication of those solutions in the context of policy development.
Prerequisite(s): CHE 3144 and CHE 3185
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4144 - Business and Marketing Strategies for the Process Industries (3 credits)
Business strategies and industrial marketing concepts, and their application in the chemical, pharmaceutical and related process industries. The course is designed for engineers and other students planning a career in the process industries. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MKTG 4144

CHE 4185 - Process and Plant Design (4 credits)
Chemical process synthesis and plant design, economic analysis of alternative processes, process equipment design and specifications, computer-aided process design and simulation, design case studies, application of scientific and engineering knowledge to practical design problems. Grade of C- or better in all CHE prefix courses and in-major GPA of 2.0 or better is required.
Prerequisite(s): CHE 3015 and (CHE 3044 or CHE 3154) and CHE 3124 and CHE 3134 and CHE 3144 and (CHE 3184 or CHE 3185) and ENGL 3764
Instructional Contact Hours: (4 Lec, 4 Crd)

CHE 4186 - Process and Plant Design (4 credits)
Chemical process synthesis and plant design, economic analysis of alternative processes, process equipment design and specifications, computer-aided process design and simulation, design case studies, application of scientific and engineering knowledge to practical design problems. Grade of C- or better in all CHE prefix courses and in major GPA of 2.0 or better is required.
Prerequisite(s): CHE 4185
Instructional Contact Hours: (4 Lec, 4 Crd)

CHE 4214 - Introduction to Polymer Materials (3 credits)
Basics of polymeric materials including description and categorization of macromolecules; characterization; mechanical properties; rubbery, glassy, crystalline, and viscous flow behavior.
Prerequisite(s): CHEM 2536 and CHE 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4224 - Introduction to Polymer Processing (3 credits)
Basic principles of momentum and heat transfer applied to the analysis of polymer processing operations. Introduction to polymer rheology.
Prerequisite(s): CHE 3144 and (CHE 3044 or CHE 3154)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4304 - Biological Transport Phenomena (3 credits)
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/ consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation.
Prerequisite(s): (CHE 3114 and CHE 3044 and CHE 3144) or (ME 3304 and ME 3404)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4344

CHE 4334 - Introduction to Colloidal and Interfacial Science (3 credits)
Properties and behavior of colloidal systems, primarily in liquid environments. Size characterization and description, Brownian motion, interparticle forces, dispersion stability, and experimental techniques for characterizing these systems.
Prerequisite(s): CHEM 3615 or CHE 2164
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4404 - Machine Learning in Chemical Sciences and Engineering (3 credits)
Development and application of data-driven computational models. Focus on applications in chemical sciences and engineering (e.g., materials discovery, property prediction, anomaly detection, process optimization). Preprocessing, data management and visualization, clustering, classification, and regression algorithms, and common pitfalls and practices in training and evaluation of data-driven models. Pre: 3124
Prerequisite(s): CHE 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

CHE 4544 - Protein Separation Engineering (3 credits)
Concepts, principles and applications of various unit operations used in protein separations. Properties of biological materials, such as cells and proteins, and their influences on process design. Design of processes for protein purification based on the impurities to be eliminated. Concepts and principles of scale-up of unit operations. Case studies in practical protein recovery and purification issues, with a focus on enhanced protein purification by genetic engineering. Protein purification process simulation and optimization using process simulation software.
Prerequisite(s): BSE 3504 or CHE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4544

CHE 4904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHE 4994H - Undergraduate Research (1-19 credits)
Honors course
Instructional Contact Hours: Variable credit course

Chemical Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHE 2114	Mass and Energy Balances (C-)	3
CHE 2164	Chemical Engineering Thermodynamics	3
CHE 3015	Process Measurement & Control	3
CHE 3114	Fluid Transport	3
CHE 3134	Separation Processes	3
CHE 3144	Mass Transfer	3
CHE 3154	Heat Transfer Analysis	3
CHE 3185	Chemical Reactor Analysis and Design	2
Subtotal		23
Major Requirements		
CHE 2004	Chemical Engineering Sophomore Seminar	1
CHE 3124	Chemical Engineering Simulations and Process Modeling	3
CHE 3186	Chemical Reactor Analysis and Design	2
CHE 4014	Chemical Engineering Laboratory [1]	4
CHE 4185	Process and Plant Design [1]	4
CHE 4186	Process and Plant Design	4
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry	3
or CHEM 2565	Principles of Organic Chemistry	
CHEM 2536	Organic Chemistry	3
or CHEM 2566	Principles of Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 3625	Physical Chemistry Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2214	Introduction to Differential Equations	
STAT 4604	Statistical Methods for Engineers	3
or STAT 4705	Probability and Statistics for Engineers	
Major Electives		
CHE Electives		*6*
Technical Electives		*6*
Career Bridge Experience [2]		
ENGE 3900	Bridge Experience [2]	
Subtotal		55
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7		3
Subtotal		50
Total Credits		**128**

[1] Entry into CHE 4014 Chemical Engineering Laboratory and CHE 4185 Process and Plant Design is restricted to students who have an in-major GPA of 2.0 or better.

[2] Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BS CHE degree. Because some of these experiences are not credit bearing, the **ENGE 3900** course is used to track and assess student participation in a Career Bridge Experience and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan. Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in **CHE 2004**.

CHE Electives

A total of 6 hours of CHE elective are required from the following list. If you take more than six hours, the excess hours will count toward Technical Electives. All CHE Electives must be taken A-F. Students are responsible for the satisfaction of prerequisites required for their chosen electives.

Code	Title	Credits
CHE 4104	Process Materials	3
CHE 4114	Energy and Climate Change Solutions	3
CHE 4214	Introduction to Polymer Materials	3
CHE 4224	Introduction to Polymer Processing	3
CHE 4304	Biological Transport Phenomena	3
CHE 4334	Introduction to Colloidal and Interfacial Science	3
CHE 4404	Machine Learning in Chemical Sciences and Engineering	3

Technical Electives

A total of 6 hours of technical electives are required from the following list. All Technical Electives must be taken A-F. No courses may double-count as both CHE elective and technical elective. Students are responsible for the satisfaction of prerequisites required for their chosen electives. If there is a course you are interested in taking and it is not on the approved list, talk to Dr. Goldstein for approval to substitute a course.

Code	Title	Credits
Biochemistry		
BCHM 2024	Concepts of Biochemistry	3
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
BCHM 4115	General Biochemistry	4
BCHM 4116	General Biochemistry	3
Biomedical Engineering		
BMES 2104	Introduction to Biomedical Engineering	3
BMES 4064	Introduction to Medical Physiology	3
Chemical Engineering		
CHE 4104	Process Materials	3
CHE 4114	Energy and Climate Change Solutions	3
CHE 4214	Introduction to Polymer Materials	3
CHE 4224	Introduction to Polymer Processing	3
CHE 4304	Biological Transport Phenomena	3
CHE 4334	Introduction to Colloidal and Interfacial Science	3
CHE 4404	Machine Learning in Chemical Sciences and Engineering	3
CHE 4544	Protein Separation Engineering	3
CHE 4974	Independent Study [3]	1-3
CHE 4994	Undergraduate Research [3]	1-3
Chemistry		
CHEM 2114	Analytical Chemistry	3
CHEM 3615	Physical Chemistry	3
CHEM 3626	Physical Chemistry Laboratory	1
CHEM 4074	Laboratory in Polymer Science	2
CHEM 4114	Instrumental Analysis	3
CHEM 4124	Instrumental Analysis Laboratory	1
CHEM 4404	Physical Inorganic Chemistry	3
CHEM 4414	Inorganic Chemistry Lab	2
CHEM 4514	Green Chemistry	3
CHEM 4524	Identification of Organic Compounds	3
CHEM 4534	Organic Chemistry of Polymers	3
CHEM 4554	Drug Chemistry	3
CHEM 4616	Physical Chemistry for the Life Sciences	3
CHEM 4624	Materials Chemistry in Energy Sciences	3
CHEM 4634	Polymer and Surface Chemistry	3
CHEM 4734	Environmental Soil Chemistry	3
CHEM 4994	Undergraduate Research [3]	1-19
Civil and Environmental Engineering		
CEE 5104	Environmental Chemistry	3
Computer Science		
CS 3114	Data Structures and Algorithms	3
Engineering		
ENGR 3124	Introduction to Green Engineering	3
Food Science and Technology		
FST 4104	Applied Brewing Science and Engineering	3
FST 4504	Food Chemistry	3
Mathematics		
MATH 4564	Operational Methods for Engineers	3
Materials Science and Engineering		
MSE 3204	Fundamentals of Electronic Materials	3
MSE 4394	Introduction to Molecular Dynamics Simulation	3
MSE 4544	Laboratory In Polymer Science	2
MSE 4574	Biomaterials	3
Nuclear Science and Engineering		
NSEG 3145	Fundamentals of Nuclear Engr	3
Physics		
PHYS 3324	Modern Physics	4
PHYS 4564	Polymer Physics	3
Sustainable Biomaterials		
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SBIO 3454	Society, Sustainability Biomaterials and Energy	3

[3] **4974** Independent Study and **4994** Undergraduate Research cannot be requested through online course request. Interested students are encouraged to contact potential research mentors, who will initiate the process. Contact Drs Martin and Bortner for more information about ChemE Car and ChemE Cube Teams, respectively.

Tracks in Chemical Engineering

Students who complete 9 credits from any of the following sets of courses will have completed a "Track." While this will not be acknowledged on the student's transcript or diploma, the student is welcome to identify the completion of the Track on their resume/curriculum vitae. Undergraduate research must be in a topic closely related to track and no more than 3 credits of approved research may be applied toward a track. Completion of a track is not required for the BS degree in CHE.

Climate and Energy Solutions Track

Chemical Engineers design and operate many industrial and power plants and can influence the output of CO 2 and other greenhouse gases, as well as other chemicals and materials that can negatively impact the environment. Chemical Engineers can positively impact climate change through process design, selection of appropriate materials, and careful control of process operating conditions, and through the implementation of decarbonization and climate change mitigation strategies. "Climate and Energy Solutions" is a track within the Chemical Engineering major where students will receive additional training in areas such as sustainable and renewable energy production, increased efficiency, decarbonization, green and sustainable materials, planning for low energy and low environmental impacts, and other strategies for mitigating climate change and environmental effects. By judicial selection of courses, students may complete the Green Engineering minor and Climate and Engineering Solutions track.

Code	Title	Credits
CHE 4114	Energy and Climate Change Solutions	3
Select a minimum of 6 credit hours from the following:		
CEE 4134	Environmental Sustainability - A Systems Approach	3
CHE 4994	Undergraduate Research	1-19
CHEM 4514	Green Chemistry	3
CHEM 4624	Materials Chemistry in Energy Sciences	3
ECE 4364	Alternate Energy for Climate Sustainability	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ESM 4194	Sustainable Energy Solutions for a Global Society	3
ME 4154	Industrial Energy Systems	3
ME 4324	Energy Systems: Theory and Applications	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SBIO 3454	Society, Sustainability Biomaterials and Energy	3

Computational and Data Sciences Track

Large-scale numerical simulations and autonomous experimentation have revolutionized many disciplines in science and engineering. To meet the growing workforce demand for tackling massive amounts of data in chemical industries, the “Computational and Data Sciences” track offers a uniquely interdisciplinary set of courses teaching the basic methodologies and applied tools of data analytics with domain-specific examples. The track prepares students for a broad variety of career paths that leverage computation and data for solving urgent societal problems: from energy and biomedical materials design, to advanced manufacturing, to intelligent chemical processes with on-the-fly diagnosis, forecasting, and optimization, to opportunities not yet foreseen.

Code	Title	Credits
CHE 4404	Machine Learning in Chemical Sciences and Engineering	3
Select a minimum of 6 credit hours from the following:		
AOE 4024	An Introduction to the Finite Element Method	3
CHE 4994	Undergraduate Research	1-19
CMDA 4654	Intermediate Data Analytics and Machine Learning	3
CS 4884	Computational Biology and Bioinformatics Capstone	3
MSE 4394	Introduction to Molecular Dynamics Simulation	3

Healthcare Technologies Track

Chemical Engineering principles are central to a broad range of bioengineering solutions to health and medicine problems, including protein and pharmaceutical engineering, tissue engineering, fermentation, wastewater treatment, and the development of novel bioreactors for product synthesis. The “Healthcare Technologies” track will allow students with a particular interest in one or more of these topics to focus their technical electives in that area. By judicial selection of courses, students may complete the Biomedical Engineering minor and Healthcare Technologies track.

Code	Title	Credits
CHE 4304	Biological Transport Phenomena	3
Select a minimum of 6 credit hours from the following:		
BMES 4064	Introduction to Medical Physiology	3
CHE 4544	Protein Separation Engineering	3
CHE 4994	Undergraduate Research	1-19
CHEM 4554	Drug Chemistry	3
CS 4884	Computational Biology and Bioinformatics Capstone	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
MSE 4574	Biomaterials	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CHE Department fully supports this policy. Specific expectations for satisfactory progress for Chemical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Students must maintain a minimum in-major GPA of 2.0.
- If in-major GPA drops below 2.0, students will be placed on departmental probation.
- If an in-major GPA of 2.0 or better is not achieved after two semesters of departmental probation, the student is suspended from the department and prohibited from registering for CHE courses for at least one semester.
- Following suspension, permission of the department head is required for registration in CHE-prefix courses.

Graduation Requirements

- Have a minimum in-major GPA of 2.0.
- Complete at least 128 semester credit hours with a minimum overall GPA of 2.0.

In-Major GPA

All CHE-prefix courses except CHE 4144 Business and Marketing Strategies for the Process Industries are used to calculate in-major GPA.

Acceptable Substitutions

1. MATH 2405H (5 cr) may be substituted for MATH 2114 (3 cr)
2. MATH 2405H (5 cr) + MATH 2406H (5 cr) may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + MATH 2214 (3 cr)
3. CHE 4015 (2 cr) + CHE 4016 (2 cr) may be substituted for CHE 4014 (4 cr)
4. CHEM 1055 (4 cr) may be substituted for CHEM 1035 (3 cr)
5. CHEM 1056 (4 cr) may be substituted for CHEM 1036 (3 cr)
6. CHEM 1065 (1 cr) may be substituted for CHEM 1045 (1 cr)
7. CHEM 1066 (1 cr) may be substituted for CHEM 1046 (1 cr)
8. CHEM 2555 (2 cr) may be substituted for CHEM 2545 (1 cr)

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable	4
ENGE 1215	Foundations of Engineering	2
Elective (Pathways Concept 2, 3, or 7)		3
	Credits	**16**
Spring Semester		
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4
ENGE 1216	Foundations of Engineering	2
	Credits	**17**
Second Year		
Fall Semester		
CHEM 2535 or CHEM 2565	Organic Chemistry or Principles of Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHE 2114	Mass and Energy Balances (C-)	3
PHYS 2306	Foundations of Physics	4
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
	Credits	**17**
Spring Semester		
CHEM 2536 or CHEM 2566	Organic Chemistry or Principles of Organic Chemistry	3
CHE 2004	Chemical Engineering Sophomore Seminar	1
CHE 2164	Chemical Engineering Thermodynamics	3
CHE 3134	Separation Processes	3
MATH 2214	Introduction to Differential Equations	3
Elective (Pathways Concept 2, 3, or 7)		3
	Credits	**16**
Third Year		
Fall Semester		
CHE 3114	Fluid Transport	3
CHE 3124	Chemical Engineering Simulations and Process Modeling	3
CHE 3185	Chemical Reactor Analysis and Design	2
ENGL 3764	Technical Writing	3
Elective (Pathways Concept 2, 3, or 7)		3
	Credits	**14**
Spring Semester		
CHEM 3625	Physical Chemistry Laboratory	1
CHE 3015	Process Measurement & Control	3
CHE 3154	Heat Transfer Analysis	3
CHE 3144	Mass Transfer	3
Select one of the following:		3
STAT 4604	Statistical Methods for Engineers	
STAT 4705	Probability and Statistics for Engineers	
	Credits	**13**
Summer Semester		
CHE 4014	Chemical Engineering Laboratory	4
	Credits	**4**
Fourth Year		
Fall Semester		
CHE 3186	Chemical Reactor Analysis and Design	2
CHE 4185	Process and Plant Design	4
ENGE 3900	Bridge Experience	0
Elective (Pathways Concept 2, 3, or 7)		3
CHE Elective		3
Technical Elective		3
	Credits	**15**
Spring Semester		
CHE 4186	Process and Plant Design	4
CHE Elective		3
Technical Elective		3
Elective (Pathways Concept 2, 3, or 7)		3
Elective (Pathways Concept 6a)		3
	Credits	**16**
	Total Credits	**128**

Civil and Environmental Engineering

Our Website (http://www.cee.vt.edu)

Overview

Civil engineers are responsible for designing, constructing, maintaining, operating, and deconstructing society's infrastructure and stewardship of its open spaces. Examples of infrastructure include, but are not limited to, buildings, industrial facilities, bridges, drinking water systems, waste treatment systems, airports, highways, dams, flood control systems, coastal facilities, stormwater management facilities, and overall land development design. Examples of providing stewardship of open spaces include mediating existing pollution in bodies of water (e.g., Chesapeake Bay), mitigation of and resilience to natural and human-made hazards, protecting our coastlines, and mitigation/control of air pollution.

The Charles Edward Via, Jr. Department of Civil and Environmental Engineering offers an undergraduate program that facilitates the development of critical analytical abilities and the necessary fundamental knowledge and skills for entry into the civil engineering profession or graduate studies. This body of knowledge includes the basic principles of science and mathematics and their application to solving human problems. Civil engineering activities interact in many ways with the natural and social environments within which they take place. Accordingly, the civil engineering program strives to create an awareness of the ecological, social, economic, and political context of engineering and attempts to prepare the civil engineer for the necessary interactions with other professions and the public. An effort to instill an understanding of the role of the civil engineer in satisfying societal needs is an integral part of the civil engineering program.

Failure of a civil engineering system can result in loss of life. The Civil Engineering Code of Ethics requires that "Civil Engineers conduct themselves with integrity and professionalism, and above all else protect and advance the health, safety, and welfare of the public through the practice of Civil Engineering." This statement serves as a guiding principle for how the CEE Department approaches the professional preparation of its students for a career in this industry.

Program Educational Objectives and Student Learning Outcomes

Program Educational Objectives (PEOs) are statements that describe the expectations of graduates within 3-5 years after graduation. The CEE faculty, alumni, and employers have worked collaboratively to develop the PEOs of the Civil Engineering undergraduate program.

The **Program Educational Objectives** of the Civil Engineering undergraduate program are that, within a few years of program completion, alumni should:

1. Serve society in the practice of civil engineering or related professions and develop into leaders within their chosen fields.
2. Adhere to state and local rules of professional conduct and uphold the American Society of Civil Engineers Code of Ethics.
3. Apply civil engineering principles in the design, construction, operation, and maintenance of infrastructure and environmental systems, recognizing the complete life cycle, including deconstruction and reuse.
4. Communicate effectively over all mediums, fostering meaningful interactions with other technical disciplines, coworkers, clients, the public, and policymakers.
5. Exhibit proficiency in technical problem-solving.

Student Learning Outcomes are statements that describe what students are expected to know and be able to do at the time of graduation. At graduation, Civil Engineering students will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Bachelor of Science program in Civil Engineering is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (http://www.abet.org/), under the General Criteria and the Program Criteria for Civil and Similarly Named Engineering Programs.

Curriculum

The freshman and sophomore years provide the mathematics, engineering mechanics, and basic science training that serves as the foundation of upper-division courses. During these first two years, students also gain a common technical background in the major. Selection of upper-division courses begins during the second semester of the sophomore year.

The civil engineering profession is broad and is composed of the following sub-disciplines: Construction Engineering and Management, Environmental Engineering, Geotechnical Engineering, Land Development, Materials Engineering, Structural Engineering, Transportation Engineering, and Water Resources Engineering. These sub-disciplines are organized into "Program Areas" that contain faculty with specific expertise in that sub-discipline and that teach and maintain undergraduate and graduate courses particular to that area. The undergraduate program provides unique flexibility to select coursework across the sub-disciples to produce graduates that are broadly trained but also provides depth within a student's area of interest. Further specialization in a particular sub-discipline is available through graduate study. The Civil Engineering program offers two majors: the Civil Engineering Major (p. 822) and the Environmental Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/civil-environmental-engineering/environmental-engineering-bs/).

Students are progressively exposed to civil engineering design through the curriculum, culminating in a focused design course experience. The projects assigned in design courses are open-ended, incorporate appropriate engineering standards, and require the application of knowledge from earlier courses in the curriculum. Projects not only apply technical knowledge to design appropriate physical facilities, but also include consideration of non-technical constraints that confront real-world projects. These additional considerations include such interdisciplinary issues as economics, environmental impact, and sustainability. Accordingly, teamwork and good professional communication skills are a significant part of each design project course experience.

Classroom instruction in the civil engineering program is reinforced by instructional laboratories in the major areas of civil engineering practice. These laboratory experiences provide training in collecting, analyzing, interpreting, and presenting data.

The department participates in the Cooperative Education and Internship Program in which qualified students may take a semester away from their education to gain valuable professional work experience. The department encourages all students to participate in professional work opportunities prior to graduation.

The contact person for undergraduate Civil and Environmental Engineering majors within the Civil Engineering program is Lauren Varboncoeur, CEE Academic Advisor at (540) 231-0981 or e-mail: lvarboncoeur@vt.edu (laurpv1@vt.edu).

Students earning the Bachelor of Science in Civil Engineering possess the technical skills required to enter practice as civil or environmental engineers in a wide range of organizations. Some students choose to pursue graduate education, leading to the M.Eng., M.S., or Ph.D. in civil engineering. Graduate degree programs are available in all Program Areas. Refer to the Graduate Catalog (https://secure.graduateschool.vt.edu/graduate_catalog/) for more information.

Civil Engineering Program

Admission to a degree program is competitive, with departmental restrictions established each year by the college. Entry into a degree-granting department requires that a student complete all first year required courses and maintain a competitive GPA. Applicants who begin their freshman year in the College of Engineering and earn a minimum 3.0

overall are guaranteed first choice of major. More information is available through the Engineering Education Department: https://eng.vt.edu/academics/undergraduate-students/resources-support/change-of-major.html.

The graduation requirements in effect during the academic year of admission to Virginia Tech apply. Requirements for graduation are listed for the Civil Engineering Major (p. 822) and the Environmental Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/civil-environmental-engineering/environmental-engineering-bs/). Students must satisfactorily complete all requirements and university obligations for degree completion. The university reserves the right to modify requirements in a degree program.

- Civil Engineering Major (p. 822)
- Environmental Engineering Major (https://catalog.vt.edu/undergraduate/college-engineering/civil-environmental-engineering/environmental-engineering-bs/)

Head and Professor: M.A. Widdowson
Associate Head and Nick Prillaman Professor: P.J. Vikesland
Associate Head and Reynolds Metals Professor: S.W. Case
Associate Head and Professor: C.L. Roberts-Wollmann
Charles E. Via, Jr. Professor: R.L. Leon and J. C. Little
Charles P. Lunsford Professor: M.A. Edwards and L.C. Marr
David H. Burrows Professor: M.J. Garvin
Dan Pletta Professor: G.W. Flintsch
Montague-Betts Professor: M.R. Eatherton
Samuel Reynolds Pritchard Professor: H.A. Rakha
University Distinguished Professor: M.A. Edwards, L.C. Marr, and A.J. Pruden
Vecellio Professor of Construction Engineering: D. Ford
W. Thomas Rice Professor: A.J. Pruden
Professors: M.M. Abbas, T.L. Brandon, A.M. Dietrich, D.L. Gallagher, S.B. Grant, R.A. Green, E.T. Hester, J.L. Irish, W.R. Knocke, A. Rodriguez-Marek, S.K. Sinha, K. Strom, and A.A. Trani
Associate Professors: S. Abdelaziz, H. Foroutan, K.L. Hancock, S. Hotle, G. Isaacman-VanWertz, E. Jacques, F. Jazizadeh Karimi, I.A. Koutromanos, L. Marston, E.W. Shealy, and A. Yerro Colom
Assistant Professors: M. Arul Jayachandran, A.S. Brand, M.S. Hasnine, J. Liao, D. Muñoz, F. Paige, A. Phillips, M.A. Rippy, R. Sarlo, S. Saksena, and J. Vantassell,
Professors of Practice: J.E. Dove and B.J. Katz
Associate Professors of Practice: R.P. Scardina, C.M. White, and K.D. Young
Assistant Professors of Practice: M. Biscotte and H. Casey
Research Assistant Professors: B. Castellanos and R. Hosseini
Undergraduate Program Writing Coordinator: C. Branscome
Emeritus Faculty: G.D. Boardman, F.A. Charney, T.E. Cousins, W.E. Cox, J. de la Garza, D.R. Drew, J.M. Duncan, R.L. Dymond, W.S. Easterling, G.M. Filz, R.C. Hoehn, S.M. Holzer, J.M. Hughes, D.F. Kibler, T. Kuppusamy, M. Mauldon, J.K. Mitchell, T.M. Murray, J.T. Novak, R.H. Plaut, C.W. Randall, K.B. Rojiani, D. Teodorovic, M.C. Vorster, and R.E. Weyers
Academic Advisor: L. Varboncoeur
Director of External and Alumni Relations: C.E. Sakry
Alumni Relations Manager: K. Lattimer

Undergraduate Course Descriptions (CEE)

CEE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2804 - Introduction to Civil and Environmental Engineering (3 credits)
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2814 - Geomatics (4 credits)
Introduction to data measurement issues in the civil and environmental engineering sub disciplines. Collection techniques, analysis, errors, statistical description and visualization. Spatial measurements such as leveling, distance and angles, mapping and topographic surveys, the Global Positioning System, LiDAR, terrain models, earthwork methods, construction surveying, coordinate systems, and Geographic Information Systems. Non-CEE students are exempt from the CEE 2834 corerequisite.
Prerequisite(s): ENGE 1216 or ENGE 1414
Corequisite(s): CEE 2834
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

CEE 2834 - Civil Engineering Drawings and Virtual Modeling (3 credits)
Introduction to the use of Computer-Aided Drafting, Building Information Modeling and Geographic Information Systems software. Interpretation of civil engineering drawings. Creation of civil engineering plans and two- and three- dimensional visualizations. Professional collaboration tools. Basemap creation. Basic analysis tools utilizing Geographic Information Systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3014 - Construction Management (3 credits)
Introduction to the fundamental elements involved in managing construction projects. Project lifecycle, delivery methods and contracts, equipment and labor productivity, scheduling, and cost estimating and control. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3104 - Introduction to Environmental Engineering (3 credits)
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations.
Prerequisite(s): CHEM 1035 and CHEM 1045 and (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024) and (PHYS 2305 or PHYS 2205)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3274 - Introduction to Land Development Design (3 credits)
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development.
Prerequisite(s): CEE 2814 and (CEE 2824 or CEE 2834)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3304 - Fluid Mechanics for Civil and Environmental Engineering (4 credits)
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. Design Lab/Studio. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): ESM 2104 and CEE 2804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3314 - Water Resources Engineering (4 credits)
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. Design Lab/Studio.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3404 - Introduction to Structural Engineering (3 credits)
Introduction to structural engineering as an art and science and its fundamental tenets; description of structural systems, structural loads, and load paths; structural models, case studies of successful and unsuccessful structural designs; calculations of forces and deformation for simple determinate structures (trusses, beams and simple frames) and indeterminate structures using virtual work, use of stiffness methods in computer programs.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3424 - Reinforced Concrete Structures I (3 credits)
Behavior and design of reinforced concrete members based on ultimate strength. Uncertainty, load and resistance factors. Load paths in framing systems. Beams, columns and slabs in flexure and shear. Deflections and crack control. Design of reinforced concrete members. Columns under axial forces, shear and flexure.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or BC 2044)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3434 - Design of Steel Structures I (4 credits)
Properties and behavior of structural steel. Design of steel members and connections using American Institute of Steel Construction specifications. Consideration of loads, structural safety, and serviceability. Design of members to resist tension, compression, and bending. Design of basic steel connections including tension connections, bearing plates, and base plates. Team-based design project to design a simple steel framed building. Design Lab/Studio.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or ESM 3054 or BC 2044)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3514 - Introduction to Geotechnical Engineering (4 credits)
Introduction to soil as an engineering material for construction and infrastructure support. Geological processes, soil classification, phase relations, geostatic and applied stresses, permeability, seepage effects, settlement, and strength. Laboratory testing, interpretation, and presentation of results. Application of geotechnical principles to civil and environmental engineering problems. Design Lab/Studio.
Prerequisite(s): ESM 2204 and GEOS 2104
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3604 - Introduction to Transportation Engineering (3 credits)
Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3684 - Civil Engineering Materials (4 credits)
Fundamental nature and performance of civil infrastructure materials, including metals, portland cement concrete, asphalt concrete, polymers, and wood. Material properties, microstructure, and mechanical behavior. Laboratory experimental procedures and standardized testing, property variability, durability, sustainability and resilience. Design of cementitious and asphalt mixtures, experimental design, non-destructive testing. Design lab/studio.
Prerequisite(s): CHEM 1045 and CHEM 1035 and ESM 2204 and GEOS 2104 and (CEE 2814 or CEM 2824)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3804 - Computer Applications for Civil and Environmental Engineers (3 credits)
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3814 - Analytical Tools in Civil and Environmental Engineering (3 credits)
Computer programming and data analysis for civil and environmental engineering projects. Acquiring, cleaning and pre-processing data sets. Probability distributions, hypothesis testing, and regression modeling. Time series and frequency analysis. Data visualization.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CEE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4014 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 4024

CEE 4024 - Construction Control Techniques (3 credits)
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4034 - Smart Sustainable Infrastructure (3 credits)
Challenges and barriers to sustainable infrastructure. Effects of a changing planet and society on current infrastructure systems. Technology and data use for engineering. Infrastructure data interpretation. Data-driven engineering solutions.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4074 - Construction Engineering: Means and Methods (3 credits)
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget.
Prerequisite(s): CEE 3014 or CEM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4104 - Water and Wastewater Treatment Design (3 credits)
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4114 - Fundamentals of Public Health Engineering (3 credits)
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4134 - Environmental Sustainability - A Systems Approach (3 credits)
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4144 - Air Resources Engineering (3 credits)
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4174 - Solid and Hazardous Waste Management (3 credits)
Introduction to the problems, regulations and techniques associated with the management of solid and hazardous waste. Composition, volume and characterization of the wastes. Design of collection and disposal systems, including landfills, solidification/stabilization and incineration. A grade of C- or better required in pre-requisite 3104.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4254 - Municipal Engineering (3 credits)
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4264 - Sustainable Land Development (3 credits)
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4274 - Land Development Design (3 credits)
Overview of land development projects including construction practices, legal issues, and government policies. Feasibility study, engineering evaluation. Grading and roadway design, layout design of lots, buildings, streets, sewers, and stormwater control. Interactive graphics and automated drafting.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4284 - Advanced Land Development Design (3 credits)
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required.
Prerequisite(s): CEE 3274
Corequisite(s): CEE 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4304 - Hydrology (3 credits)
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4314 - Groundwater Resources (3 credits)
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4324 - Open Channel Flow (3 credits)
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4334 - Hydraulic Structures (3 credits)
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4344 - Water Resources Planning (3 credits)
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4384 - Coastal Engineering (3 credits)
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4394 - Urban Water Sustainability (3 credits)
Coupled socio-hydrologic feedback loops and implications for water systems resilience. Urban water transitions theory and the evolution of water systems through time. Water productivity and the soft path for water. Ecosystem services. Urban water system challenges, including climate change, urbanization, equity and environmental justice, and water security. Centralized and distributed drinking water, stormwater, and wastewater treatment systems. Statistical analysis of urban water systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4404 - Intermediate Structural Analysis (3 credits)
Analysis of statically indeterminate 2D and 3D beam, truss and frame structures by the force and displacement methods. Computer implementation of force method. Influence lines and approximate methods of analysis.
Prerequisite(s): CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4454 - Masonry Structural Design (3 credits)
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures.
Prerequisite(s): CEE 3684 and CEE 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4514 - Methods in Geotechnical Engineering (3 credits)
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4534 - Earth Pressures and Foundation Structures (3 credits)
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4544 - Design of Earth Structures (3 credits)
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4554 - Natural Disaster Mitigation and Recovery (3 credits)
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4564 - Introduction to Coastal and Marine Geotechnics (3 credits)
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is required in prerequisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4604 - Traffic Engineering (3 credits)
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4610 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4044

CEE 4614 - Concrete Materials (3 credits)
Fundamental properties of portland cement concretes. Concrete mixture design procedures. Testing of fresh and hardened properties of concrete. Durability and degradation mechanisms. Condition assessments, forensic materials engineering, and repair strategies.
Prerequisite(s): CEE 3684 or BC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4624 - Planning Transportation Facilities (3 credits)
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4634 - Infrastructure Condition Assessment (3 credits)
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4654 - Geometric Design of Highways (3 credits)
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4664 - Pavement Design (3 credits)
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4674 - Airport Planning and Design (3 credits)
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4684 - Transportation Safety (3 credits)
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4694 - Freight Operations (3 credits)
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4804 - Professional and Legal Issues in Civil Engineering (3 credits)
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): CEE 2804
Corequisite(s): CEE 3304
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4814 - Risk and Reliability Analysis in Civil and Environmental Engineering (3 credits)
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4824 - Introduction to Forensic Engineering (3 credits)
Basic processes in engineering failure investigations: response, data gathering, testing, modeling, and reporting. Origins of natural and man-made disasters, role of building codes and material specifications, standard of care, ethical standards and legal issues as related to forensic engineering.
Prerequisite(s): CEE 3684 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4834 - Cyber-Physical and Remote Sensing Methods in Civil Engineering (3 credits)
Cyber-physical systems and remote sensing methods in civil engineering. Electrodynamics and fundamental physical operating principles. Sensing and sensor deployment strategies. Data acquisition and reduction. Signal and image processing techniques. Data interpretation, management, and curation.
Prerequisite(s): CEE 3814 or BSE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4844 - Building Information Modeling and Integrated Practices (3 credits)
Introduction to Building Information Modeling (BIM). Architectural modeling, custom parametric object creation, virtual structural modeling. Constructability and construction management analysis. Reality capturing technologies. Virtual reality and immersive virtual environments. Contemporary topics and new directions for BIM technologies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Civil Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CEE 2834	Civil Engineering Drawings and Virtual Modeling (C-)	3
CEE 2814	Geomatics (C-)	4
CEE 3814	Analytical Tools in Civil and Environmental Engineering	3
Select two CEE Fundamental Electives (with Lab)		8
Select four CEE Fundamental Electives		12
Subtotal		30
Major Requirements		
CHEM 1045	General Chemistry Laboratory (C-)	1
ESM 2104	Statics (C-)	3
ESM 2204	Mechanics of Deformable Bodies (C-)	3
GEOS 2104	Elements of Geology (C-)	3
ISE 2014	Engineering Economy	2
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2214	Introduction to Differential Equations	3
Select three CEE Advanced Electives		9
Select one CEE Advanced Elective (Design Project)		3
Career Bridge Experience [1]		
ENGE 3900	Bridge Experience	0
Technical and Restricted Electives		
Select appropriate electives from the two lists shown.		12
Subtotal		45
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
CEE 2804	Introduction to Civil and Environmental Engineering (1A)	3
CEE 3304	Fluid Mechanics for Civil and Environmental Engineering (1A)	4
CEE 4804	Professional and Legal Issues in Civil Engineering (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
CHEM 1035	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F ; C-)	4
CEE 3804	Computer Applications for Civil and Environmental Engineers (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D ; C-) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double-counted with either a Pathways 2 or 3 course to avoid taking any additional credit hours.		
Subtotal		53
Total Credits		**128**

CEE Electives

The CEE department requires 12 credits of **Fundamental Electives**, 8 credits of **Fundamental Electives with lab**, 9 credits of **Advanced Electives**, 3 additional credits of **Advanced Electives (Design Project)**, and 12 credits of **Technical** and **Restricted Electives** as follows.

Fundamental and Advanced Electives (32 credits)

Fundamental and Advanced Electives provide adequate breadth across the discipline and depth of knowledge in specialty areas of interest. Interdisciplinary Technical Electives, Independent Study, and Undergraduate Research courses do not satisfy these requirements but may be taken to satisfy the Technical Electives.

Fundamental and Advanced Electives are selected from the list below and must meet the following criteria:

1. Complete *Fundamental courses* in 6 of the 8 specialty areas, at least two of which must have a lab (20 credits). These courses count toward satisfying degree core requirements.
2. Complete one *Advanced course* in 3 of the 6 specialty areas in which *Fundamental courses* were selected in Step 1 (9 credits).
3. Complete one additional *Advanced course* in a specialty area in which *an Advanced course* was selected in Step 2 (3 credits).
4. Within the selections made above, complete at least one *Design Project course*.

Technical and Restricted Electives (12 credits)

Technical Electives include any course selected from the list of Fundamental, Advanced, and Interdisciplinary Technical Electives. Restricted Electives are earned by selecting courses from the approved list of Restricted Electives or selecting courses within an officially declared minor selected from the list of approved minors. Technical and Restricted Electives can be satisfied in one of three ways as follows:

1. Complete 6 credits of Technical Electives and 6 credits of Restricted Electives

2. Complete 9 credits of Technical electives and 3 credits of Restricted Electives
3. Complete 12 credits of Technical Electives

Another option for earning Technical and Restricted Electives allows students to request substitution of up to 6 credits of Restricted Electives for up to 6 credits of Technical Electives. To be considered for the substitution option, students must follow these steps:

1. Meet with an Academic Advisor. Discuss the goals for the substitutions and seek guidance. Students should carefully consider their options and ensure they are making the best choices for their educational and professional development.
2. Develop a Plan of Study. Outline which courses you wish to substitute and how they fit into your overall academic plan.
3. Prepare a Written Proposal. In the narrative, describe the added value of the courses to your degree and career aspirations. Clearly articulate how the courses will help you achieve your professional goals.
4. Verbal Presentation. Orally defend your proposal to the Associate Department Head for Undergraduate Affairs or their designee.

Fundamental, Advanced and Interdisciplinary Technical Electives

Code	Title	Credits
Construction Engineering and Management		
CEE 3014	Construction Management (Fundamental)	3
CEE 4014	Estimating, Production, and Cost Engineering [2]	3
CEE 4024	Construction Control Techniques	3
CEE 4034	Smart Sustainable Infrastructure	3
CEE 4074	Construction Engineering: Means and Methods	3
Structural Engineering and Materials		
CEE 3404	Introduction to Structural Engineering (Fundamental)	3
CEE 3424	Reinforced Concrete Structures I	3
CEE 3434	Design of Steel Structures I [2]	4
CEE 4404	Intermediate Structural Analysis	3
CEE 4454	Masonry Structural Design	3
Environmental Engineering		
CEE 3104	Introduction to Environmental Engineering (Fundamental)	3
CEE 4104	Water and Wastewater Treatment Design [2]	3
CEE 4114	Fundamentals of Public Health Engineering	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
CEE 4144	Air Resources Engineering	3
CEE 4174	Solid and Hazardous Waste Management	3
Materials		
CEE 3684	Civil Engineering Materials (Fundamental with lab)	4
CEE 4610	Mechanics of Composite Materials	3
CEE 4614	Concrete Materials	3
CEE 4634	Infrastructure Condition Assessment	3
CEE 4664	Pavement Design [2]	3
Land Development		
CEE 3274	Introduction to Land Development Design (Fundamental)	3
CEE 4264	Sustainable Land Development	3
CEE 4274	Land Development Design [2]	3
CEE 4284	Advanced Land Development Design	3
Geotechnical Engineering		
CEE 3514	Introduction to Geotechnical Engineering (Fundamental with lab)	4
CEE 4514	Methods in Geotechnical Engineering	3
CEE 4534	Earth Pressures and Foundation Structures	3
CEE 4544	Design of Earth Structures [2]	3
CEE 4564	Introduction to Coastal and Marine Geotechnics	3
Water Resources Engineering		
CEE 3314	Water Resources Engineering (Fundamental with lab)	4
CEE 4304	Hydrology	3
CEE 4314	Groundwater Resources	3
CEE 4324	Open Channel Flow	3
CEE 4334	Hydraulic Structures [2]	3
CEE 4344	Water Resources Planning	3
CEE 4384	Coastal Engineering	3
CEE 4394	Urban Water Sustainability	3
Transportation Engineering		
CEE 3604	Introduction to Transportation Engineering (Fundamental)	3
CEE 4604	Traffic Engineering	3
CEE 4624	Planning Transportation Facilities	3
CEE 4654	Geometric Design of Highways [2]	3
CEE 4674	Airport Planning and Design	3
CEE 4684	Transportation Safety	3
CEE 4694	Freight Operations	3
Interdisciplinary Technical Electives, Independent Study, Undergraduate Research		
CEE 4554	Natural Disaster Mitigation and Recovery	3
CEE 4824	Introduction to Forensic Engineering	3
CEE 4844	Building Information Modeling and Integrated Practices	3
CEE 4834	Cyber-Physical and Remote Sensing Methods in Civil Engineering	3
CEE 4974	Independent Study	1-19
CEE 4994	Undergraduate Research	1-19
5000-Level Advanced Electives		
Students in their senior year with a 3.00 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements. See your academic advisor.		

Restricted Electives

Code	Title	Credits
Study Abroad		
CEE 3954	Study Abroad	1-19
Programming		
CS 1044	Introduction to Programming in C	3
CS 1064	Introduction to Programming in Python	3
CS 1114	Introduction to Software Design	3
CS 2064	Intermediate Programming in Python	3
Engineering Fundamentals, Mechanics, and Materials		
AOE 4054	Stability of Structures	3

BSE 3154	Thermodynamics of Biological Systems	3
CHE 2114	Mass and Energy Balances	3
ESM 3054	Mechanical Behavior of Materials	3
ESM 2304	Dynamics	3
ISE 3204	Manufacturing Processes [3]	3
ME 2134	Thermodynamics [3]	4
MSE 2034	Elements of Materials Engineering	3
MSE 4304	Metals and Alloys [3]	3
SBIO 2124	Structure and Properties of Sustainable Biomaterials	3
SBIO 3324	Green Building Systems	3
SBIO 4314	Design of Wood Structures	3
SBIO 4714	Performance of Sustainable Biomaterials in Buildings	3
Statistics and Math		
MATH 3414	Numerical Methods	3
MATH 4564	Operational Methods for Engineers	3
STAT 4604	Statistical Methods for Engineers	3
Science		
CHEM 1036	General Chemistry	3
PHYS 2306	Foundations of Physics	4
BIOL 1105	Principles of Biology	3
GEOS 3014	Environmental Geosciences	3
GEOG 3304	Geomorphology	3
GEOS 4634	Environmental Geochemistry	3
GEOS 4824	Engineering Geology	3
Public Policy and Planning		
SPIA 2314	Active Transportation for a Healthy, Sustainable Planet	3
SPIA 2554	Collaborative Policy-Making and Planning	3
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	3
SPIA 3704	Urban Contention and Mobilization	3
SPIA 4454	Future of Cities	3
SPIA 4464	Data and the Art of Policy-Making and Planning	3
UAP 3014	Urban Policy and Planning	3
UAP 3024	Urban and Regional Analysis	3
UAP 3224	Policy Implementation [3]	3
Real Estate		
REAL 4754	Real Estate Law	3
UAP 2004	Principles of Real Estate	3
REAL 2034	Real Estate Data Analysis	3
Sustainability, Environment, Climate Change		
GEOG 2244	Sustainable Urbanization	3
AAEC 3314	Environmental Law	3
BSE 3324	Small Watershed Hydrology	3
BSE 4224	Field Methods in Hydrology	3
CEM 3074	Global Design and Construction for Sustainable Development	3
FREC 2124	Forests, Society & Climate	3
FREC 4464	Water Resources Policy and Economics	3
FREC 4784	Wetland Hydrology and Biogeochemistry	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4374	Land Use and Environment: Planning and Policy	3
Geographic Information Science		
BSE 4344	Geographic Information Systems for Engineers	3
GEOG 2084	Principles of Geographic Information Systems	3
Business, Management, and Economics		
AAEC 2104	Personal Financial Planning	3
AAEC 3324	Environment and Sustainable Development Economics	3
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
ISE 4304	Global Issues in Industrial Management [3]	3
Construction		
CEM 2714	Construction Safety Systems	3
CEM 4714	Construction Safety Culture	3
CEM 4724	Construction Industry Futures: Safety, Health, and Wellness	3

Approved Minors

- Business (BUSR)
- Computer Science (CS)
- Data and Decisions (DTDC)
- Economics (ECAS)
- Engineering Science and Mechanics (ESM)
- Entrepreneurship-New Venture Growth (ENVG)
- Environmental Policy and Planning (EPP)
- Geographic Information Science (GIS)
- Geosciences (GEOS)
- Green Engineering (GREN)[4]
- Industrial Design (IDS)
- Innovation (INNO)
- Mathematics (MATH)
- Professional and Technical Writing (PTW)
- Public and Urban Affairs (PUA)
- Real Estate (REAL)
- Smart and Sustainable Cities (SSC)
- Statistics (STAT)
- Watershed Management (WSM)

[1] Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BSCE degree. Because some of these experiences are not credit bearing, the ENGE 3900 course is used to track and assess student participation in Career Bridge and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan.

Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in CEE 2804.

2 Design Project Course

3 Enrollment is on a space-available basis during drop-add.

4 Electives chosen within the minor must include 6 credit hours of non CEE courses that do not satisfy BSCE degree requirements.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CEE Department fully supports this policy. Specific expectations for satisfactory progress for Civil Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (undergradcatalog.registrar.vt.edu/ (http://undergradcatalog.registrar.vt.edu/)).
- A 2.0 overall GPA and a 2.0 in-major GPA must be maintained for continued enrollment in CEE. The in-major GPA consists of all courses taken with a CEE designator.
- Upon completion of 64 GPA hours, a student must have satisfactorily completed CEE 2804 Introduction to Civil and Environmental Engineering, CEE 2814 Geomatics, and CEE 2834 Civil Engineering Drawings and Virtual Modeling.
- Be enrolled in at least one 3-credit CEE course each fall and spring semester.

Graduation Requirements

Students must pass all required courses and both the in-major and overall GPA must be at least 2.0 for graduation. The in-major GPA consists of all courses taken under the CEE designation.

C- Policy

A C- or better grade is required in any course that is a prerequisite for a CEE course. The notation (C-) is provided for first and second-year advising purposes only and indicates that those courses are prerequisites for a course with a CEE designator.

Additional Comments

Displayed course offerings are subject to sufficient resources. Courses are taught in the term in which they appear on the roadmap. CEE Fundamentals courses are typically taught each fall and spring term, whereas CEE Advanced courses may not be offered each academic term. Consult the CEE course listing and your departmental advisor for updates.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations
3. ESM 2114 Statics & Structures may be substituted for ESM 2104 Statics
4. ME 3024 Engineering Design and Economics may be substituted for ISE 2014 Engineering Economy
5. ESM 2114 Statics & Structures + AOE 2024 Thin-Walled Structures may be substituted for ESM 2104 Statics and ESM 2204 Mechanics of Deformable Bodies

Foreign Language Requirements

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry (C-)	3
CHEM 1045	General Chemistry Laboratory (C-)	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering	2
Pathways		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable (C-)	4
PHYS 2305	Foundations of Physics (C-)	4
ENGE 1216	Foundations of Engineering (C-)	2
Pathways		3
	Credits	**16**
Second Year		
Fall Semester		
ESM 2104	Statics (C-)	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
CEE 2834	Civil Engineering Drawings and Virtual Modeling (C-)	3
CEE 2804	Introduction to Civil and Environmental Engineering (C-)	3
	Credits	**15**
Spring Semester		
ESM 2204	Mechanics of Deformable Bodies (C-)	3
GEOS 2104	Elements of Geology (C-)	3
CEE 3804	Computer Applications for Civil and Environmental Engineers (C-)	3
MATH 2214	Introduction to Differential Equations	3
CEE 2814	Geomatics (C-)	4
	Credits	**16**
Third Year		
Fall Semester		
CEE 3304	Fluid Mechanics for Civil and Environmental Engineering	4
ISE 2014	Engineering Economy	2
CEE Fundamental Elective (with Lab)		4
CEE Fundamental Elective		3
Pathways		3
	Credits	**16**
Spring Semester		
CEE 3814	Analytical Tools in Civil and Environmental Engineering	3
CEE Fundamental Elective (with Lab)		4
CEE Fundamental Elective		3

CEE Fundamental Elective		3
CEE 4804	Professional and Legal Issues in Civil Engineering	3
	Credits	**16**
Fourth Year		
Fall Semester		
CEE Fundamental Elective		3
CEE Advanced Elective (Design Project)		3
CEE Advanced Elective		3
Technical Elective		3
Restricted Electives		3
Pathways		3
	Credits	**18**
Spring Semester		
CEE Advanced Elective		3
CEE Advanced Elective		3
Technical Elective		3
Restricted Elective		3
Pathways		3
	Credits	**15**
	Total Credits	**128**

Computer Science

Our Website (http://www.cs.vt.edu)

The Field of Computer Science

In a contemporary world where every educated person must have some knowledge of computing, the Department of Computer Science offers degree programs and courses to meet a variety of needs. The department offers a bachelor of science degree to prepare specialists in the area of computer science itself, a minor in computer science, minors in specialized areas such as cybersecurity and human-computer interaction, and individual courses directed to the needs of non-majors who will be using computers as tools in their chosen careers. The department also offers the M.S., M.Eng., and Ph.D. in computer science (see Graduate Catalog (https://catalog.vt.edu/graduate/)).

Computer science involves far more than just writing computer programs. It is a technically rigorous field that requires a strong background in mathematics. Computer scientists must be good at problem solving. Their work requires the ability to think abstractly and to represent real-world objects and interactions in ways that can be manipulated by a computer. The field of computer science is characterized by rapid change and entrepreneurship, with new opportunities emerging every year to improve life in diverse areas such as education, communication, science, commerce and entertainment.

Accreditation, Program Educational Objectives, and Student Learning Outcomes

The Bachelor of Science degree in Computer Science is accredited by the Computing Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Computer Science and Similarly Named Engineering Programs.

Part of the accreditation process is a clear statement of program educational objectives and desired student learning outcomes for graduates. The following program educational objectives describe what graduates of the Virginia Tech Computer Science undergraduate program are expected to attain within a few years of graduation. Alumni will have:

- Demonstrated technical expertise by applying computer science knowledge and practice to solve challenging problems, whether in employment, graduate study, or individual pursuits;
- Advanced their skills in communication, teamwork, and professional and ethical behavior;
- Demonstrated leadership in their technical or professional pursuits;
- Engaged in post-graduate learning through graduate studies, professional improvement opportunities, or self-study;
- Served society through professional or personal contribution.

These objectives are supported by a curriculum that seeks to have its graduates achieve the following student learning outcomes upon graduation. Graduates of the program will have an ability to:

1. Analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
3. Communicate effectively in a variety of professional contexts.
4. Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline.
6. Apply computer science theory and software development fundamentals to produce computing-based solutions.

Degree Requirements

Students pursuing the Bachelor of Science Degree in Computer Science choose one of three majors. The Computer Science major is designed to provide a broad computer science background that will prepare a student for a wide variety of professional careers or to continue study at the graduate level. The Secure Computing major offers a more specialized path for students who are especially interested in secure computing and cybersecurity topics. The Data-Centric Computing Major offers a focus on topics in data science, data analytics, and computational aspects of big data computing. All majors include a set of foundational courses in software design and development, algorithms, and computer organization at the freshmen and sophomore level. Students at the junior and senior level select one theoretical course, several elective courses and a capstone course according to their individual interests.

Opportunities for Majors

The department offers computer science majors the opportunity to enhance their education through a variety of curricular and extracurricular activities. Students who meet the requirements for independent study or undergraduate research can pursue research or individualized study under the direction of a faculty member. Through the Honors College, qualified students can work toward earning an Honors Laureate Diploma for their degree. Students may also elect to earn both the bachelor's and master's degrees in an accelerated undergraduate/graduate program. The Cooperative Education Program makes it possible for students to acquire professional experience while pursuing their degree. The department's corporate partnership program hosts large career fairs in both Fall and Spring semesters.

The department sponsors multiple student organizations, including the student chapter of the Association for Computing Machinery (ACM), the Association for Women in Computing (AWC), the CS Community Service organization, and the Programming Team. Additional opportunities for experiential learning and professional development include serving as a teaching assistant or department ambassador, attending a professional development or research conference, participating in study abroad opportunities, and participating in annual research competitions and hackathons. Financial aid is available through numerous college and department endowed scholarships.

Information for Non-Majors

The department offers a Computer Science minor for non-majors seeking a solid general background in computer science. The department also offers minors focused on human-computer interaction and cybersecurity. Please visit the department's undergraduate program website for more information.

Computational Facilities

The Department of Computer Science possesses extensive computational facilities for both instruction and research. There are several undergraduate teaching laboratories and a number of specially equipped research laboratories. These include large parallel computing clusters and numerous compute and file servers for research and instruction in areas such as artificial intelligence, machine learning, digital libraries, software engineering, bioinformatics and networking. The department also operates extensively equipped laboratories for human-computer Interaction, virtual environments and information visualization. Students studying computer science are supported by two department-specific Undergraduate Learning Centers on campus.

- Computer Science Major (p. 833)
- Data-Centric Computing Major (p. 837)
- Secure Computing Major (p. 841)

Head: C. Julien
Associate Department Head for Undergraduate Studies: S. H. Edwards
Associate Department Head for Graduate Studies: E. Tilevich
Associate Department Head for Faculty Development: A. R. Butt
Associate Department Head for Research: T. M. Murali
Thomas L. Phillips Professor: N. Ramakrishnan
Frank J. Maher Professor: D. Bowman
W.C. English Professor: W. Lou
John W. Hancock Professor: D. Nikolopoulos
Professors: O. Balci, A. R. Butt, K. W. Cameron, S. H. Edwards, W. Feng, S. Flammia, E. A. Fox, L. S. Heath, M. Kantarcioglu, B. Knapp, C. T. Lu, R. McMahan, T. M. Murali, C. Noh, C. L. North, A. Onufriev, C. Reddy, C. Ribbens, A. Sandu, C. A. Shaffer, E. Tilevich, D. Yao, and L. Zhang.
Associate Professors: G. Back, D. Bhattacharya, Y. Cao, J. H. Cho, H. Eldardiry, D. Gracanin, M. Hicks, X. Jian, B. Ji, A. Karpatne, K. Luther, D. S. McCrickard, and N. Meng.
Assistant Professors: C. Brown, Y. Chen, T. Chung, B. David-John, P. Gao, M. Gulzar, S. Hasan, T. Hoang, S. Khatri, S. W. Lee, H. Li, A. Mantri, E. Rho, P. Sashittal, J. Sikora, K. Sundararajah, C. Thomas, B. Viswanath, T. Vu, X. Wang, D. Williams, I. Williams, P. Yanardag, Y. Yao, and D. Zhou.
Associate Professors of Practice: M. Ellis and G. Kulczycki
Collegiate Associate Professors: B. Edmison, S. Hamouda, S. Hooshangi, E. Olimpiew, R. Jafari, and M. Seyam.
Collegiate Assistant Professors: M. Cameron, O. Emebo, M. Farghally, V. Garg, T. Mengistu, and S.B. Nizamani.
Advanced Instructors: D. McPherson
Instructors: S. Cao, H. Hillman, A Senger, and P. Sullivan
Professor Emeritus: D. C. S. Allison, J. D. Arthur, R. W. Ehrich, D. G. Kafura, J. A. N. Lee, H. R. Hartson, R. E. Nance, B. Ryder, D. Tatar, and L. T. Watson

E-mail: csundergrad@cs.vt.edu

Undergraduate Course Descriptions (CS)

CS 1014 - Introduction to Computational Thinking (3 credits)
An exploration of basic ideas of computational thinking focusing on the perspectives, thought processes, and skills that underlie computational approaches to problem formulation and problem solving. Applications of computational tools to investigate complex, large-scale problems in a variety of knowledge domains. Basic introduction to algorithms and a practical programming language. Examination of the societal and ethical implications of computational systems.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1044 - Introduction to Programming in C (3 credits)
Fundamental concepts underlying software solutions of many problems. Structured data, statement sequencing, logic control, input/output, and functions. The course will be taught using a structured approach to programming. Partially duplicates 1344.
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1054 - Introduction to Programming in Java (3 credits)
An introduction to object-oriented programming using the Java language. Fundamental concepts underlying programming and software solutions to many problems. Structured data, statement sequencing, logic control, classes, objects, methods, instantiation of classes, sending messages to objects. The impact of computing on issues of diversity and inclusion.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1064 - Introduction to Programming in Python (3 credits)
Introduction to programming in Python contextualized with scientific and engineering problems. Computational problem-solving skills and software solutions in addition to Python language fundamentals. The basics of control flow with loops and conditionals, state tracing and manipulation, simple and complex types, organization of code using functional and object-oriented coding strategies, and data processing. Create, interpret, and debug programs. Ethically debate important issues in computing culture.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 1114 - Introduction to Software Design (3 credits)
Fundamental concepts of programming from an object-oriented perspective. Basic software engineering principles and programming skills in a programming language that supports the object-oriented paradigm. Simple data types, control structures, array and string data structures, basic algorithms, testing and debugging. A basic model of the computer as an abstract machine. Modeling and problem-solving skills applicable to programming at this level. Partially duplicates 1054, 1124, and 1705.
Corequisite(s): MATH 1225
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

CS 1944 - Computer Science First Year Seminar (1 credit)
An introduction to academic and career planning for computer science majors.
Prerequisite(s): CS 1114 or CS 2064 or ECE 2514
Instructional Contact Hours: (1 Lec, 1 Crd)

CS 2064 - Intermediate Programming in Python (3 credits)
Advanced uses of control flow and data processing, data structures, computational techniques, object-oriented programming, and modern data science pipelines. Creating, interpreting, and debugging complex programs. Problems and projects contextualized for scientists and engineers. Implementation of Python programs in data science and production environments, production of object-oriented solutions to complex problems, and ethical implications of technological change.
Prerequisite(s): CS 1064
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2104 - Introduction to Problem Solving in Computer Science (3 credits)
This course introduces the student to a broad range of heuristics for solving problems in a range of settings that are relevant to computation. Emphasis on problem-solving techniques that aid programmers and computer scientists. Heuristics for solving problems in the small (classical math and word problems), generating potential solutions to real-life problems encountered in the profession, problem solving through computation, and problem solving in teams.
Prerequisite(s): (MATH 1205 or MATH 1225 or MATH 1526) and (CS 1114 or CS 2064 or ECE 2514)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2114 - Software Design and Data Structures (3 credits)
A programming-intensive exploration of software design concepts and implementation techniques. Builds on knowledge of fundamental object-oriented programming. Advanced object-oriented software design, ethics in computing, algorithm development and analysis, and classic data structures. Includes a team-based software project.
Prerequisite(s): CS 1114 or CS 2064
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CS 2144 - Competitive Problem Solving I (3 credits)
Fundamentals of algorithms, data structures, and implementation techniques, taught in a setting that combines collaborative practice with competitive exercise. Students practice to solve problems using a computer, which are judged by automated evaluation software for correctness and efficiency. Practice with data structures including arrays, lists, maps, and trees, as well as algorithmic strategies including recursion, divide-and-conquer, dynamic programming, search and traversal algorithms, graph representations, and computational geometry. Macro- and micro optimization techniques to improve efficiency are emphasized.
Prerequisite(s): CS 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 2164, PSCI 2164

CS 2304 - Topics in Programming Systems (1 credit)
Guided self-study in a specific programming system, its syntax and applications. Based on prior knowledge of the programming process and experience in programming with some high-level language. Systems include JavaScript, C++, CUDA, Ruby, SQL, FORTRAN, UNIX, etc. May be taken three times for credit with different system each time. May be taken only twice for CS major or minor credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

CS 2505 - Introduction to Computer Organization (3 credits)
An introduction to the design and operation of digital computers. Works up from the logic gate level to combinational and sequential circuits, information representation, computer arithmetic, arithmetic/logic units, control unit design, basic computer organization, relationships between high level programming languages and instruction set architectures. A grade of C or better is required in CS prerequisite. Corequisites: MATH 2534 or MATH 3034.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2506 - Introduction to Computer Organization (3 credits)
An introduction to the design and operation of digital computers. Instruction formats and construction, addressing modes, instruction execution, memory hierarchy operation and performance, pipelining, input/output, and the relationships between high level programming languages and machine language. A grade of C or better is required in CS pre-requisite 2505 and 2114.
Prerequisite(s): (CS 2114 or ECE 3514) and (CS 2505 or ECE 2564) and (MATH 2534 or MATH 3034)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 2984E - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

CS 3114 - Data Structures and Algorithms (3 credits)
Advanced data structures and analysis of data structure and algorithm performance. Sorting, searching, hashing, and advanced tree structures and algorithms. File system organization and access methods. Ethical issues in the context of data analysis and software performance. Course projects require advanced problem-solving, design, and implementation skills.
Prerequisite(s): (CS 2114 or ECE 3514) and (CS 2505 or ECE 2564) and (MATH 2534 or MATH 3034)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3214 - Computer Systems (3 credits)
Introduction to computer systems as they are relevant to application programmers today, with emphasis on operating system principles. Operating system design and architectures; processes; threads, synchronization techniques, deadlock; CPU scheduling; system call interfaces, system level I/O and file management; shell programming; separate compilation, loading and linking; inter-process communication (IPC); virtual and physical memory management and garbage collection; network protocols and programming; virtualization; performance analysis and optimization. A grade of C or better is required in CS pre-requisites 2506 and 2114.
Prerequisite(s): (CS 2506 and CS 2114) or (ECE 2564 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3274 - Software Reverse Engineering (3 credits)
Theory and practice of software reverse engineering, static and dynamic analysis techniques and tools, reverse engineering of malware, obfuscated binaries, communications and command and control analysis, reverse engineering of non-binary software.
Prerequisite(s): (CS 2114 and CS 2506) or (ECE 2534 and ECE 3514)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3304 - Comparative Languages (3 credits)
This course in programming language constructs emphasizes the run-time behavior of programs. The languages are studied from two points of view: (1) the fundamental elements of languages and their inclusion in commercially available systems; and (2) the differences between implementations of common elements in languages. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3314 - Programming Language Theory and Practice (3 credits)
Theoretical basis of programming languages, including formal languages, computability theory, type theory, and programming language design. Standard syntax notations. Fundamental programming language features for control flow and data representation. Language implementation strategies. Unsolvable problems in the context of programming languages and computing.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3414 - Numerical Methods (3 credits)
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and MATH 4404.
Prerequisite(s): (CS 1044 or CS 1705 or CS 1114 or CS 1124) and MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204H or MATH 2204)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MATH 3414

CS 3604 - Professionalism in Computing (3 credits)
Studies the ethical, social, and professional concerns of the computer science field. Covers the social impact of the computer, implications and effects of computers on society, and the responsibilities of computer professionals in directing the emerging technology. The topics are studied through case studies of reliable, risk-free technologies, and systems that provide user friendly processes. Specific studies are augmented by an overview of the history of computing, interaction with industrial partners and computing professionals, and attention to the legal and ethical responsibilities of professionals. This is a web-supported course, incorporating writing intensive exercises, making extensive use of active learning technologies. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 1944 and (CS 2114 or ECE 3514) and (COMM 2004 or COMM 2014)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3634 - Computer Science Foundations for Computational Modeling & Data Analytics (3 credits)
Survey of computer science concepts and tools that enable computational science and data analytics. Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3634

CS 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3654, STAT 3654

CS 3704 - Intermediate Software Design and Engineering (3 credits)
Explores the principles of software design in detail, with an emphasis on software engineering aspects. Includes exposure of software lifecycle activities including design, coding, testing, debugging, and maintenance, highlighting how design affects these activities. Peer reviews, designing for software reuse, CASE tools, and writing software to specifications are also covered. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3714 - Mobile Software Development (3 credits)
Technologies and concepts underlying software development for mobile devices (handheld computers). Mobile computing platforms, including architecture, operating system, and programming environment. Software design patterns and structuring for mobile applications. Network-centric mobile software development. Data persistence. Programming for mobile device components such as cameras, recorders, accelerometer, gyroscope and antennas. Location-aware software development. A grade of C or better required in CS prerequisite.
Prerequisite(s): CS 2114 or ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3724 - Introduction to Human-Computer Interaction (3 credits)
Survey of human-computer interaction concepts, theory, and practice. Basic components of human-computer interaction. Interdisciplinary underpinnings. Informed and critical evaluation of computer-based technology. User-oriented perspective, rather than system-oriented, with two thrusts: human (cognitive, social) and technological (input/output, interactions styles, devices). Design guidelines, evaluation methods, participatory design, communication between users and system developers. A grade of C or better required in CS prerequisite 2114.
Prerequisite(s): CS 1114 or CS 1044 or CS 1054 or CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3744 - Introduction to GUI Programming and Graphics (3 credits)
Design and implementation of object-oriented graphical user interfaces (GUI) and two-dimensional computer graphics systems. Implementation methodologies including callbacks, handlers, event listeners, design patterns, layout managers, and architectural models. Mathematical foundations of computer graphics applied to fundamental algorithms for clipping, scan conversion, affine and convex linear transformations, projections, viewing, structuring, and modeling. A grade of C or better is required in CS pre-requisite 2114.
Prerequisite(s): (CS 2114 or ECE 3514) and (MATH 1114 or MATH 2114) and (MATH 1224 or MATH 2204)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3754 - Cloud Software Development (3 credits)
Fundamentals of cloud software development, including design patterns, application programming interfaces, and underlying middleware technologies. Development of distributed multi-tiered enterprise software applications that run on a server computer and are accessed using a web browser over the Internet on a network-connected computer such as desktop, laptop, or handheld computer (tablet, smartphone, or mobile device. A grade of C or better is required in prerequisite.
Prerequisite(s): CS 2114 or ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3824 - Introduction to Computational Biology and Bioinformatics (3 credits)
Introduction to computational biology and bioinformatics (CBB) through hands-on learning experiences. Emphasis on problem solving in CBB. Breadth of topics covering structural bioinformatics; modeling and simulation of biological networks; computational sequence analysis; algorithms for reconstructing phylogenies; computational systems biology; and data mining algorithms. Pre-requisite: Grade of C or better in CS 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4014 - Algorithms & Society (3 credits)
This course focuses on social perspectives of algorithms and implications to factors such as class, gender, race, ethnicity, geography, and disability status. Students will be guided to think critically about the impacts of computing in society, as well as the role of social values in their design. Topics will focus on computing technologies involved in critical contemporary and global concerns including machine learning, privacy, and the infrastructure that describes the social and technical context for algorithms. Pre: Junior Standing
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4014

CS 4104 - Data and Algorithm Analysis (3 credits)
Data structures and algorithms from an analytical perspective. Theoretical analysis of algorithm efficiency. Comparing algorithms with respect to space and run-time requirements. Analytical methods for describing theoretical and practical bounds on performance. Constraints affecting problem solvability. A grade of C or better is required in CS prerequisite 3114.
Prerequisite(s): CS 3114 and (MATH 3034 or MATH 3134)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4114 - Introduction to Formal Languages and Automata Theory (3 credits)
The course presents a study of formal languages and the correspondence between language classes and the automata that recognize them. Formal definitions of grammars and acceptors, deterministic and nondeterministic systems, grammar ambiguity, finite state and push-down automata, and normal forms will be discussed.
Prerequisite(s): MATH 3134 or MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4124 - Theory of Computation (3 credits)
Theoretical analysis of the computational process; fundamental concepts such as abstract programs, classes of computational machines and their equivalence, recursive function theory, unsolvable problems, Churchs thesis, Kleenes theorem, program equivalence, and generability, acceptability, decidability will be covered.
Prerequisite(s): MATH 3134 or MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4134 - Quantum Computation and Information Processing (3 credits)
Quantum states and quantum phenomena. Quantum communication concepts such as superdense coding, teleportation, and complexity. Classical and quantum circuits and gate sets for computation. Quantum algorithms and comparison to classical algorithms. Quantum computational complexity theory and complexity classes. Quantum information concepts such as density operators, measurements, and quantum channels. Error correction, the stabilizer formalism, and fault-tolerance. The adiabatic theorem and adiabatic quantum computation. Entanglement and entanglement measures.
Prerequisite(s): MATH 2114 or MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4144 - Competitive Problem Solving II (3 credits)
Deeper treatment of advanced algorithms, data structures, and implementation techniques, taught in a setting that combines collaborative practice with competitive exercise. Students practice to solve problems using a computer, which are judged by automated evaluation software for correctness and efficiency. Practice with advanced searching and graph algorithms, advanced dynamic programming, linear programming techniques, computational geometry, and numerical algorithms. Problems are drawn from multiple areas in computer science. Macro- and micro optimization techniques to improve efficiency are emphasized.
Prerequisite(s): CS 2114 and CS 2144
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4164, PSCI 4164

CS 4204 - Computer Graphics (3 credits)
Hardware and software techniques for the display of graphical information. 2D and 3D geometry and transformations, clipping and windowing, software systems. Interactive graphics, shading, hidden surface elimination, perspective depth. Modeling and realism.
Prerequisite(s): CS 3744
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4214 - Simulation and Modeling (3 credits)
Overview of discrete-event digital computer simulation and modeling. Fundamentals of model development, Monte Carlo simulation, the life cycle of a simulation study, input and output data analysis, world views and time control, random number and variate generation, credibility assessment of simulation results, simulation languages, applications of simulation using the General Purpose Simulation System (GPSS). A grade of C or better required in CS prerequisite 2114.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4224 - Linux Kernel Programming (3 credits)
Design and internal organization of the Linux operating system kernel. Kernel subsystems, boot process, memory management, process and thread model, scheduling, interrupt and exception handling, virtual file system and the concrete file system, block I/O and I/O scheduler, network stack, and device drivers. Modification of existing kernel code. Design, implementation, test and evaluation of new kernel modules. Kernel and full software stack debugging techniques, and virtualization as an aid for operating system development and debug. Software engineering techniques to analyze, modify and run a large, complex open-source code base.
Prerequisite(s): ECE 3574 or CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4414

CS 4234 - Parallel Computation (3 credits)
Survey of parallel computer architectures, models of parallel computation, and interconnection networks. Parallel algorithm development and analysis. Programming paradigms and languages for parallel computation. Example applications. Performance measurement and evaluation. A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4244 - Internet Software Development (3 credits)
Key technology underlying the World-Wide Web. Web architecture, including client and server design, network protocols, and related standards. Static and dynamic content, caching, state management, fault tolerance, error handling. Programming systems and abstractions, e.g., sockets, remote procedures, Web services, frameworks and component models. Document representations and processing. Security. Entrepreneurial issues and emerging technologies. A grade of C or better required in CS 3214 prerequisite.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4254 - Computer Network Architecture and Programming (3 credits)
Introduction to computer network architecture, and methods for programming network services and applications (e.g. DNS, Email and MIME, http, SNMP, multimedia). Wired, wireless, and satellite network architectures. OSI protocol model, with an emphasis on upper layers. Congestion control, quality of service, routing. Internet protocol suite (e.g. IP, TCP, ARP, RARP). Server design (e.g. connectionless, concurrent). Network programming abstractions (e.g. XDR, remote procedure calls, sockets, DCOM). Case studies (e.g. TELNET). A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4264 - Principles of Computer Security (3 credits)
Survey of computer problems and fundamental computer security design principles and models for software systems. Cryptographic models and methods. Modern cyber security techniques for robust computer operating systems, software, web applications, large-scale networks and data protection. Privacy models and techniques. Contemporary computer and network security examples. A grade of C or better is required in prerequisites.
Prerequisite(s): CS 3214 or (ECE 3504 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4274 - Secure Computing Capstone (3 credits)
Advanced topics in cybersecurity and secure computing. Threat modeling through identification and analysis of security threats. Reasoning about the efficacy, complexity, cost, and ethical tradeoffs of computer security systems. Team-based approach to solving open-ended computer security problems. Designing, implementing, documenting, and presenting advanced computer systems.
Prerequisite(s): CS 3114 and CS 3214
Corequisite(s): CS 4264
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4284 - Systems & Networking Capstone (3 credits)
Advanced topics in computer systems & networking, e.g. distributed and parallel processing, emerging architectures, novel systems management & networking design, fault- tolerance, and robust and secure data management. Team- based approach to solving open-ended computer systems & networking problems. Designing, implementing and documenting advanced computer/networking systems. A grade of C or better required in CS prerequisites.
Prerequisite(s): CS 3114 and CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4304 - Compiler Design and Implementation (3 credits)
This course includes the theory, the design, and the implementation of a large language translator system. Lexical analysis, syntactic analysis, code generation, and optimization are emphasized. A grade of C or better required in CS prerequisite 3214.
Prerequisite(s): CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4414 - Issues in Scientific Computing (3 credits)
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006) and MATH 3214 and (CS 1114 or MATH 1454)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: MATH 4414

CS 4504 - Computer Organization (3 credits)
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahls Law, Flynns Taxonomy. A grade of C or better required in prerequisites.
Prerequisite(s): ECE 2500 or CS 3214 or ECE 3504
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4504

CS 4570 - Wireless Networks and Mobile Systems (3 credits)
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects.
Prerequisite(s): CS 4254 or ECE 4564
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4570

CS 4604 - Introduction to Data Base Management Systems (3 credits)
Emphasis on introduction of the basic data base models, corresponding logical and physical data structures, comparisons of models, logical data design, and data base usage. Terminology, historical evolution, relationships, implementation, data base personnel, future trends, applications, performance considerations, data integrity. Senior standing required. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4624 - Multimedia, Hypertext and Information Access (3 credits)
Introduces the architectures, concepts, data, hardware, methods, models, software, standards, structures, technologies, and issues involved with: networked multimedia information and systems, hypertext and hypermedia, networked information videoconferencing, authoring/electronic publishing, and information access. Coverage includes how to capture, represent, link, store, compress, browse, search, retrieve, manipulate, interact with, synchronize, perform, and present: text, drawings, still images, animations, audio, video, and their combinations (including in digital libraries).
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4634 - Design Of Information (3 credits)
Survey of the higher-order properties that allow data to become information, that is, to inform people. The course focuses on the analysis of user needs, user comprehension and local semantics; the design of information organization; and the design of information display appropriate to use and setting. A grade of C or better is required in CS prerequisites 3114 and 3724.
Prerequisite(s): CS 3114 and CS 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4644 - Creative Computing Studio (3 credits)
Capstone computer science course at the intersection of arts and technology. Intensive immersion in different approaches to digital arts such as game design, interactive art, digital music, and immersive virtual reality. Students work in teams to conduct an end-to-end integrative design project. A grade of C or better is required in prerequisite CS 3724.
Prerequisite(s): CS 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regulations, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4654, STAT 4654

CS 4664 - Data-Centric Computing Capstone (3 credits)
Advanced, project-based course on deriving valuable insights from real-world data collected from a variety of sources. Team-based end-to-end projects explore the entire data science workflow: problem statement, formulating the research questions, collecting preparing and cleaning data, alternating between analyzing data and interpreting results, and synthesizing results into a written report and an interactive executable codebase.
Prerequisite(s): CS 3114 and CS 3654 or CMDA 3654 or STAT 3654
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4704 - Software Engineering Capstone (3 credits)
Senior project course integrating software engineering knowledge and skills acquired in previous courses. Team- based approach to problem formulation, requirements engineering, architecture, design, implementation, integration, documentation and delivery of software system that solves a real-world problem. Pre: A grade of C or better in CS 3704.
Prerequisite(s): CS 3704 or CS 3714 or CS 3754
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

CS 4774 - Human-Computer Interaction Design Experience (3 credits)
Project-based design course in human-computer interaction. Team-based, end-to-end, integrative interface design project drawn from interdisciplinary areas of student expertise, e.g., virtual reality, augmented reality, embodied cognition, visualization, semiotic engineering, game design, personal information management, mobile computing, design tools, educational technology, and digital democracy. Not for CS major credit. Senior standing.
Prerequisite(s): CS 3724 and (HIST 2604 or SOC 2604 or STS 2604) and COMM 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4784 - Human-Computer Interaction Capstone (3 credits)
Advanced, project-based course in Human-Computer Interaction. Team-based, end-to-end, integrative interface design project drawn from area of expertise in the department, e.g., virtual reality, augmented reality, embodied cognition, visualization, semiotic engineering, game design, personal information management, mobile computing, design tools, educational technology, and digital democracy. Pre-requisite: Senior Standing required. A grade of C or better is required in CS pre-requisite 3724 and 3744
Prerequisite(s): CS 3724 and CS 3744
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4804 - Introduction to Artificial Intelligence (3 credits)
Overview of the areas of problem solving, game playing, and computer vision. Search trees and/or graphs, game trees, block world vision, syntactic pattern recognition, object matching, natural language, and robotics. Senior standing required. A grade of C or better required in CS prerequisite 3114.
Prerequisite(s): CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4824 - Machine Learning (3 credits)
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites.
Prerequisite(s): (ECE 3514 or CS 2114) and (STAT 3704 or STAT 4105 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4424

CS 4884 - Computational Biology and Bioinformatics Capstone (3 credits)
Advanced topics in computational biology and bioinformatics (CBB). Team-based approach to solving open-ended problems in CBB. Projects drawn from areas of expertise in the department, e.g., algorithms for CBB, computational models for biological systems, analysis of structure-function relationships in biomolecules, genomic data analysis and data mining, computational genomics, systems biology. Design, implementation, documentation and presentation of solutions. A grade of C or better required in CS prerequisite 3824.
Prerequisite(s): CS 3824
Instructional Contact Hours: (3 Lec, 3 Crd)

CS 4894 - Special Topics in Computer Science (3 credits)
Advanced undergraduate topics in the design, development, use, and impact of computer science solutions or software systems. Topics may include blockchain systems, DevOps, new programming languages, social media software, software as a service, micro-services, and end user programming systems. May be repeated 2 times with different content for a maximum of 9 credits.
Prerequisite(s): CS 2114 and CS 2505
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CS 4944 - Seminar (1 credit)
Prerequisite(s): CS 3604
Instructional Contact Hours: (1 Lec, 1 Crd)

CS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Computer Science Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CS 1114	Introduction to Software Design (C)	3
CS 2505	Introduction to Computer Organization (C)	3
CS 2506	Introduction to Computer Organization (C)	3
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
or CMDA 2005	Integrated Quantitative Sciences	
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	Introduction to Proofs	
Subtotal		24
Major Requirements		
CS 2104	Introduction to Problem Solving in Computer Science (C)	3
CS 3304	Comparative Languages	3
CS Theory Elective		3
CS 4/5XXX Elective [3]		3

CS 4XXX Capstone		3
Subtotal		15
Additional Course Requirements		
CS 1944	Computer Science First Year Seminar	1
CS 2114	Software Design and Data Structures (C)	3
CS 4944	Seminar	1
MATH 3134	Applied Combinatorics and Graph Theory	3
or MATH 3124	Modern Algebra	
Elective Courses		
CS 3/4/5XXX Electives [3]		6
CS Technical Elective [3]		3
Advanced Natural Science Elective		4
Communications Elective		3
Professional Writing Elective		3
Statistics Elective		3
Free Electives		7
Subtotal		37
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (use Communications Elective, Professional Writing Elective, or Free Elective)		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Natural Science Elective		4
Natural Science Elective		4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
CS 3114	Data Structures and Algorithms (5A ; C)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 can be double-counted with another core concept. In this case, additional free elective credits must be taken to maintain a minimum of 123 credits		3
Subtotal		47
Total Credits		**123**

Electives

Note: Some elective courses may include prerequisites not required by this checksheet. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

1. **Natural Science Electives:** Choose 8 credits

Code	Title	Credits
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4

2. **Advanced Natural Science Elective:** Choose 4 credits

Code	Title	Credits
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
PHYS 2306	Foundations of Physics	4

3. **Communications Elective.** Students must take one of the following:

Code	Title	Credits
COMM 2004	Public Speaking	3
COMM 2014	Speech Communication	3

Note: COMM 2004 Public Speaking can be used to satisfy Pathways 1A. Students who do not take COMM 2004 Public Speaking as their communications elective will need to satisfy Pathways 1A through a suitable professional writing elective or free elective.

4. **Professional Writing Elective.** Students must take one of the following:

Code	Title	Credits
ENGL 3764	Technical Writing	3
ENGL 3804	Technical Editing and Style	3
ENGL 3814	Creating User Documentation	3
ENGL 3824	Visual Rhetoric and Document Design	3
ENGL 3834	Intercultural Issues in Professional Writing	3
ENGL 3844	Writing and Digital Media	3
ENGL 4824	Science Writing	3

Note: ENGL 3764 Technical Writing can be used to satisfy Pathways 1A. Students who do not take ENGL 3764 Technical Writing as their communications elective will need to satisfy Pathways 1A through a suitable communications elective or free elective.

5. **Statistics Elective.** Students must take one of the following:

Code	Title	Credits
STAT 4705	Probability and Statistics for Engineers	3
STAT 4105	Theoretical Statistics [1]	3
STAT 4714	Probability and Statistics for Electrical Engineers [1]	3

STAT 4604	Statistical Methods for Engineers	3
STAT 3704	Statistics for Engineering Applications [2]	2
CMDA 2006	Integrated Quantitative Sciences [1]	6

Note: Students taking must take an additional 1 free elective credit to meet the total number of credits required for the degree. Students considering a possible change of major to Data-Centric Computing should take one of , , or , since that major uses a more restrictive list of statistics electives.

6. **CS 3/4/5XXXX Electives[3].** Other than the exceptions listed below, any 3-credit CS 3/4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 3/4/5XXX elective, including both CS 4974 Independent Study and CS 4994 Undergraduate Research. Additionally, the following cross-listed courses are allowed for CS 3/4/5XXX elective credit.

Code	Title	Credits
BIT 4614	Cybersecurity Management II	3
CMDA 3654	Introductory Data Analytics and Visualization	3
CMDA 4654	Intermediate Data Analytics and Machine Learning	3
ECE 4424	Machine Learning	3
MATH 3414	Numerical Methods	3
MATH 4414	Issues in Scientific Computing	3
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	3
STAT 3654	Introductory Data Analytics and Visualization	3
STAT 4654	Intermediate Data Analytics and Machine Learning	3
STS 4014	Algorithms & Society	3

Exceptions (not allowed to count towards CS 3/4/5XXX electives)

Code	Title	Credits
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics	3
CS 4774	Human-Computer Interaction Design Experience	3
CS 5040	Intermediate Data Structures and Algorithm Analysis	3
CS 5044	Object-Oriented Programming with Java	3
CS 5045	Computation for the Data Sciences	3
CS 5046	Computation for the Data Sciences	3
CS 5644	Machine Learning with Big Data	3
CS 5664	Social Media Analytics	3
CS 5904	Project and Report	1-19
CS 5944	Graduate Seminar	1
CS 5974	Independent Study	1-19
CS 5994	Research and Thesis	1-19

7. **CS 4/5XXXX Elective[3].** Other than the exceptions listed below, any 3-credit CS 4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 4/5XXX elective, including both CS 4974 Independent Study and CS 4994 Undergraduate Research Additionally, the following cross-listed courses are also allowed for CS 3/4/5XXX elective.

Code	Title	Credits
BIT 4614	Cybersecurity Management II	3
CMDA 4654	Intermediate Data Analytics and Machine Learning	3
ECE 4424	Machine Learning	3
MATH 4414	Issues in Scientific Computing	3
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	3
STAT 4654	Intermediate Data Analytics and Machine Learning	3
STS 4014	Algorithms & Society	3

Exceptions (not allowed to count towards the CS 4/5XXX electives.

Code	Title	Credits
CS 4774	Human-Computer Interaction Design Experience	3
CS 5040	Intermediate Data Structures and Algorithm Analysis	3
CS 5044	Object-Oriented Programming with Java	3
CS 5045	Computation for the Data Sciences	3
CS 5046	Computation for the Data Sciences	3
CS 5644	Machine Learning with Big Data	3
CS 5664	Social Media Analytics	3
CS 5904	Project and Report	1-19
CS 5944	Graduate Seminar	1
CS 5974	Independent Study	1-19
CS 5994	Research and Thesis	1-19

8. **CS Theory Elective.** Students must take one of the following:

Code	Title	Credits
CS 4104	Data and Algorithm Analysis	3
CS 4114	Introduction to Formal Languages and Automata Theory	3
CS 4124	Theory of Computation	3
CS 4134	Quantum Computation and Information Processing	3
CS 5104	Computability and Formal Languages	3
CS 5114	Theory of Algorithms	3

9. **Capstone Requirement.** Students must complete one 4000-level CS capstone course. Students may choose from the courses listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the capstone requirement.

Code	Title	Credits
CS 4274	Secure Computing Capstone	3
CS 4284	Systems & Networking Capstone	3
CS 4624	Multimedia, Hypertext and Information Access	3
CS 4634	Design Of Information	3
CS 4644	Creative Computing Studio	3
CS 4664	Data-Centric Computing Capstone	3
CS 4704	Software Engineering Capstone	3
CS 4784	Human-Computer Interaction Capstone	3
CS 4884	Computational Biology and Bioinformatics Capstone	3
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3

10. **CS Technical Elective**[3]**.** Computer Science majors must satisfy a 3 credit hour technical elective requirement by taking one of:
    a. Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (6) above.
    b. Any approved 3000- or 4000-level course in another discipline that has significant technical content relevant to the science or application of computer science can be used as a technical elective.
        i. Requests to have a non-CS course approved as a technical elective are made by submitting a course syllabus to your CS advisor for review prior to enrolling in the course. This includes non-CS Independent Study (4974) and Undergraduate Research (4994) courses.
        ii. Below is a listing of non-CS courses that are approved as technical electives.
        Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynamics	3
ART 3704	Topics in Computer Animation	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4634	Data Analysis and Visualization for Construction and Facilities Management	3
CMDA 3606	Mathematical Modeling: Methods and Tools	3
ECE 3544	Digital Design I	4
ECE 3574	Applied Software Design	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4550	Real-Time Systems	3
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964	Field Study	1-19
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG 4314	Spatial Analysis in Geographic Information Systems	3
GEOG 4324	Algorithms in Geographic Information Systems	4
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4454	Applied Mathematical Modeling	3
ME 4524	Introduction to Robotics and Automation	3
MUS 3064	Digital Sound Manipulation	3
MUS 3065	Computer Music and Multimedia Design	3
MUS 3066	Computer Music and Multimedia Design	3
PHYS 4755	Introduction to Computational Physics	3

[1] **CS Non-Technical Course Requirement.** B.S. in CS students must complete 30 credits of non-technical courses. All courses are approved as non-technical courses except those in the departments of Biological Sciences, Chemistry, Geosciences, Physics, Mathematics, and Statistics, and all departments in the College of Engineering, except for engineering courses satisfying Pathways 7. Also excluded are courses listed as CS technical electives.

[2] **Independent Study/Undergraduate Research.** No more than a total of 6 credits of CS 4974 Independent Study and/or CS 4994 Undergraduate Research may be used to fulfill CS degree requirements. To take Independent Study (CS 2974 Independent Study or CS 4974 Independent Study), a minimum overall and in-major GPA of 2.5 is required. To take CS 4994 Undergraduate Research, a minimum overall GPA of 2.5 and an in-major GPA of 3.0 is required. CS 4974 Independent Study and CS 4994 Undergraduate Research also require completion of CS 3114 Data Structures and Algorithms with a grade of **C** or better.

[3] **Undergraduates Taking Graduate Courses**. Students within 2 semesters of graduating and with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department if they have been accepted into the Accelerated Undergraduate/Graduate Program, or by permission of the course instructor and the Department. For students not accepted into the Accelerated Undergraduate/Graduate Program, these courses may not be used on the Plan of Study for a graduate degree.

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CS Department fully supports this policy. Specific expectations for satisfactory progress for Computer Science majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: http://www.undergradcatalog.registrar.vt.edu/1920/academic-policies.html#22
- Be registered in at least one 3-credit course **required** in the major during each on-campus semester of the regular academic year.
- Maintain an in-major GPA of 2.0 or better (calculated using all classes with a CS designator).
- Not take any CS course required in the major more than twice, including attempts ending in course withdrawal.
- Not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

Graduation Requirements

To qualify for a B.S. degree in CS, a student must:

1. Complete 123 credit hours
2. Earn a "C" (2.0) or better in CS 1114 Introduction to Software Design, CS 2104 Introduction to Problem Solving in Computer Science, CS 2114 Software Design and Data Structures, CS 2505 Introduction to Computer Organization, CS 2506 Introduction to Computer Organization and CS 3114 Data Structures and Algorithms.
3. Earn a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00 (the in-major GPA is calculated using all classes with a CS designator).

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H (5 cr) + MATH 2406H (5 cr) may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + free elective (4 cr)
3. CS 2064 (C) (3 cr) may be substituted for CS 1114 (C) (3 cr)
4. ECE 2514 (C) (3cr) may be substituted for CS 1114 (C) (3cr)
5. ECE 3514 (C) may be substituted for CS 2114 (C)
6. ECE 2564 (C) may be substituted for CS 2505 (C)

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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First Year		
Fall Semester		**Credits**
CS 1114	Introduction to Software Design (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Natural Science Elective		4
	Credits	**16**
Spring Semester		
CS 2114	Software Design and Data Structures (C)	3
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
Natural Science Elective		4
	Credits	**16**
Second Year		
Fall Semester		
CS 1944	Computer Science First Year Seminar	1
CS 2104	Introduction to Problem Solving in Computer Science (C)	3
CS 2505	Introduction to Computer Organization (C)	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**16**
Spring Semester		
CS 2506	Introduction to Computer Organization (C)	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus or Integrated Quantitative Sciences	3
Communications Elective		3
Advanced Natural Science Elective		4
	Credits	**16**
Third Year		
Fall Semester		
CS 3114	Data Structures and Algorithms (C)	3
CS 3/4/5XXX	Elective [3]	3
MATH 3134	Applied Combinatorics and Graph Theory	3
Professional Writing Elective		3
Pathways 2, 3, 6a, or 7		3
	Credits	**15**
Spring Semester		
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
Statistics Elective		3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**15**
Fourth Year		
Fall Semester		
CS 3304	Comparative Languages	3
CS Theory Elective		3
CS 3/4/5XXX	Elective [3]	3
CS Technical Elective [3]		3
Free Elective		3
	Credits	**15**
Spring Semester		
CS 4944	Seminar	1
CS 4XXX	Capstone	3
CS 4/5XXX	Elective [3]	3
Pathways 2, 3, 6a, or 7		3
Free Elective		4
	Credits	**14**
	Total Credits	**123**

Data-Centric Computing Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CS 1114	Introduction to Software Design (C)	3
CS 2505	Introduction to Computer Organization (C)	3
CS 2506	Introduction to Computer Organization (C)	3
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus Integrated Quantitative Sciences	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics Introduction to Proofs	3
Subtotal		24
Major Requirements		
CS 3314	Programming Language Theory and Practice	3
CS/STAT/CMDA 3654	Introductory Data Analytics and Visualization	3
CS 4XXX	Data-Centric Computing Capstone	3
Data-Centric Computing Electives [3]		12

Subtotal		21
Additional Course Requirements		
CS 1944	Computer Science First Year Seminar	1
CS 2114	Software Design and Data Structures (C)	3
CS 4944	Seminar	1
MATH 3134	Applied Combinatorics and Graph Theory	3
or MATH 3124	Modern Algebra	
Subtotal		8
Elective Courses		
CS 3/4/5XXX Elective [3]		3
CS Technical Elective [3]		3
Advanced Natural Science Elective		4
Communications Elective		3
Professional Writing Elective		3
Statistics Elective		3
Free Electives		4
Subtotal		23
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (use Communications Elective, Professional Writing Elective, or Free Elective)		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Natural Science Elective		4
Natural Science Elective		4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
CS 3114	Data Structures and Algorithms (5A ; C)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 can be double-counted with another core concept. In this case, additional free elective credits must be taken to maintain a minimum of 123 credits.		3
Subtotal		47
Total Credits		**123**

Additional Requirements and Notes

Double Major Restriction: students pursing a Major in Data-Centric Computing may not double major in the Major in Computational Modeling and Data Analytics or one of the major concentrations/options listed under the Bachelor of Science in Computational Modeling and Data Analytics.

Data-Centric Computing Electives

Note: Some elective courses may include prerequisites not required by this checksheet. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

1. **Natural Science Electives:** Choose 8 credits

Code	Title	Credits
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4

2. **Advanced Natural Science Elective:** Choose 4 credits

Code	Title	Credits
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
PHYS 2306	Foundations of Physics	4

3. **Communications Elective.** Students must take one of the following:

Code	Title	Credits
COMM 2004	Public Speaking	3
COMM 2014	Speech Communication	3

Note: COMM 2004 Public Speaking can be used to satisfy Pathways 1A. Students who do not take COMM 2004 Public Speaking as their communications elective will need to satisfy Pathways 1A through a suitable professional writing elective or free elective.

4. **Professional Writing Elective.** Students must take one of the following:

Code	Title	Credits
ENGL 3764	Technical Writing	3
ENGL 3804	Technical Editing and Style	3
ENGL 3814	Creating User Documentation	3
ENGL 3824	Visual Rhetoric and Document Design	3
ENGL 3834	Intercultural Issues in Professional Writing	3
ENGL 3844	Writing and Digital Media	3
ENGL 4824	Science Writing	3

Note: ENGL 3764 Technical Writing can be used to satisfy Pathways 1A. Students who do not take ENGL 3764 Technical Writing as their communications elective will need to satisfy Pathways 1A through a suitable communications elective or free elective.

5. **Statistics Elective.** Students must take one of the following:

Code	Title	Credits
STAT 4705	Probability and Statistics for Engineers	3
STAT 4105	Theoretical Statistics	3
CMDA 2006	Integrated Quantitative Sciences	6

6. **CS 3/4/5XXXX Electives[3].** Other than the exceptions listed below, any 3-credit CS 3/4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 3/4/5XXX elective, including both CS 4974 Independent Study and CS 4994 Undergraduate Research. Additionally, the following cross-listed courses are allowed for CS 3/4/5XXX elective credit.

Code	Title	Credits
BIT 4164	Future of Security: Integrative Solutions for Complex Security Systems	3
CMDA 4654	Intermediate Data Analytics and Machine Learning	3
ECE 4424	Machine Learning	3
ECE 4504	Computer Organization	3
ECE 4570	Wireless Networks and Mobile Systems	3
MATH 3414	Numerical Methods	3
MATH 4414	Issues in Scientific Computing	3
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	3
STAT 4654	Intermediate Data Analytics and Machine Learning	3

Exceptions (not allowed to count towards CS 3/4/5XXX electives)

Code	Title	Credits
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics	3
CS 4774	Human-Computer Interaction Design Experience	3
CS 5040	Intermediate Data Structures and Algorithm Analysis	3
CS 5044	Object-Oriented Programming with Java	3
CS 5045	Computation for the Data Sciences	3
CS 5046	Computation for the Data Sciences	3
CS 5644	Machine Learning with Big Data	3
CS 5664	Social Media Analytics	3
CS 5904	Project and Report	1-19
CS 5944	Graduate Seminar	1
CS 5974	Independent Study	1-19
CS 5994	Research and Thesis	1-19

7. **Data-Centric Computing Elective[3].** Students must take four of the following:

Code	Title	Credits
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4624	Cybersecurity Analytics for Business	3
CMDA/STAT/CS 4654	Intermediate Data Analytics and Machine Learning	3
CS/MATH 3414	Numerical Methods	3
CS 3824	Introduction to Computational Biology and Bioinformatics	3
CS/MATH 4414	Issues in Scientific Computing	3
CS 4604	Introduction to Data Base Management Systems	3
CS 4804	Introduction to Artificial Intelligence	3
CS 4824/ ECE 4424	Machine Learning	3
STAT 3504	Nonparametric Statistics	3
STAT 4214	Methods of Regression Analysis	3
STAT 4444	Applied Bayesian Statistics	3
CS 5054	Programming Models for Big Data	3
CS 5124	Algorithms in Bioinformatics	3
CS 5424	Computational Cell Biology	3
CS 5465		3
CS 5466		3
CS 5474	Finite Difference Methods for Partial Differential Equations	3
CS 5484	Finite Element Methods for Partial Differential Equations	3
CS 5485	Numerical Analysis and Software	3
CS 5486	Numerical Analysis and Software	3
CS 5525	Data Analytics	3
CS 5526	Statistical Learning	3
CS 5614	Database Management Systems	3
CS 5764	Information Visualization	3
CS 5814	Introduction to Deep Learning	3
CS 5854	Computational Systems Biology	3

8. **Data-Centric Computing Capstone Requirement.** Students must complete one 4000-level CS capstone course in the data-centric computing area. Students may choose the course listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the data-centric computing capstone requirement.

Code	Title	Credits
CS 4624	Multimedia, Hypertext and Information Access	3
CS 4664	Data-Centric Computing Capstone	3
CS 4884	Computational Biology and Bioinformatics Capstone	3

With prior departmental approval, CS 4414 Issues in Scientific Computing or MATH 4414 Issues in Scientific Computing or ENGE 4735 Interdisciplinary Design Capstone or ENGE 4736 Interdisciplinary Design Capstone can fulfill the capstone requirement in semesters where the course includes a significant data-centric computing aspect.

9. **CS Technical Elective[3].** Data-Centric Computing majors must satisfy a 3 credit hour technical elective requirement by taking one of:
   a. Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (6) above.
   b. Any Data-Centric Computing Elective listed under (6) above that is not otherwise used to fulfill a Data-Centric Computing requirement.
   c. Any approved 3000- or 4000-level course in another discipline that has significant technical content relevant to the science or application of computer science can be used as a technical elective.
      i. Requests to have a non-CS course approved as a technical elective are made by submitting a course syllabus to your CS advisor for review prior to enrolling in the course.

This includes non-CS Independent Study (4974) and Undergraduate Research (4994) courses.

ii. Below is a listing of non-CS courses that are approved as technical electives.
Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynamics	3
ART 3704	Topics in Computer Animation	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4634	Data Analysis and Visualization for Construction and Facilities Management	3
CMDA 3606	Mathematical Modeling: Methods and Tools	3
ECE 3544	Digital Design I	4
ECE 3574	Applied Software Design	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4550	Real-Time Systems	3
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964 INTERDISCIPLINARY DESIGN PROJECT		
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG 4314	Spatial Analysis in Geographic Information Systems	3
GEOG 4324	Algorithms in Geographic Information Systems	4
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4454	Applied Mathematical Modeling	3
ME 4524	Introduction to Robotics and Automation	3
MUS 3064	Digital Sound Manipulation	3
MUS 3065	Computer Music and Multimedia Design	3
MUS 3066	Computer Music and Multimedia Design	3
PHYS 4755	Introduction to Computational Physics	3

[1] **CS Non-Technical Course Requirement.** B.S. in CS students must complete 30 credits of non-technical courses. All courses are approved as non-technical courses except those in the departments of Biological Sciences, Chemistry, Geosciences, Physics, Mathematics, and Statistics, and all departments in the College of Engineering, except for engineering courses satisfying Pathways 7. Also excluded are courses listed as CS technical electives.

[2] **Independent Study/Undergraduate Research.** No more than a total of 6 credits of CS 4974 Independent Study and/or CS 4994 Undergraduate Research may be used to fulfill CS degree requirements. To take Independent Study (CS 2974 Independent Study or CS 4974 Independent Study), a minimum overall and in-major GPA of 2.5 is required. To take CS 4994 Undergraduate Research, a minimum overall GPA of 2.5 and an in-major GPA of 3.0 is required. CS 4974 Independent Study and CS 4994 Undergraduate Research also require completion of CS 3114 Data Structures and Algorithms with a grade of **C** or better.

[3] **Undergraduates Taking Graduate Courses**. Students within 2 semesters of graduating and with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department if they have been accepted into the Accelerated Undergraduate/Graduate Program, or by permission of the course instructor and the Department. For students not accepted into the Accelerated Undergraduate/Graduate Program, these courses may not be used on the Plan of Study for a graduate degree.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CS Department fully supports this policy. Specific expectations for satisfactory progress for Computer Science majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (http://www.undergradcatalog.registrar.vt.edu/1920/academic-policies.html#22).
- Be registered in at least one 3-credit course required in the major during each on-campus semester of the regular academic year.
- Maintain an in-major GPA of 2.0 or better (calculated using all classes with a CS designator).
- Not take any CS course required in the major more than twice, including attempts ending in course withdrawal.
- Not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

Graduation Requirements

To qualify for a B.S. degree in CS, a student must:

1. Completed at least 123 credit hours
2. Earn a “C” (2.0) or better in CS 1114 Introduction to Software Design, CS 2114 Software Design and Data Structures, CS 2505 Introduction to Computer Organization, CS 2506 Introduction to Computer Organization and CS 3114 Data Structures and Algorithms.
3. Earn a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00 (the in-major GPA is calculated using all classes with a CS designator).

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + free elective (4 cr)
3. CS 2064 (C) may be substituted for CS 1114
4. ECE 2514 (C) may be substituted for CS 1114 (C)
5. ECE 3514 (C) may be substituted for CS 2114 (C)
6. ECE 2564 (C) may be substituted for CS 2505 (C)

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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Roadmap

First Year		
Fall Semester		**Credits**
CS 1114	Introduction to Software Design (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Natural Science Elective		4
	Credits	**16**
Spring Semester		
CS 2114	Software Design and Data Structures (C)	3
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
Natural Science Elective		4
	Credits	**16**
Second Year		
Fall Semester		
CS 1944	Computer Science First Year Seminar	1
CS 2505	Introduction to Computer Organization (C)	3
MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus or Integrated Quantitative Sciences	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**16**
Spring Semester		
CS 2506	Introduction to Computer Organization (C)	3
MATH 2114	Introduction to Linear Algebra	3
Communications Elective		3
Statistics Elective		3
Advanced Natural Science Elective		4
	Credits	**16**
Third Year		
Fall Semester		
CS 3114	Data Structures and Algorithms (C)	3
CS 3654 or STAT 3654 or CMDA 3654	Introductory Data Analytics and Visualization or Introductory Data Analytics and Visualization or Introductory Data Analytics and Visualization	3
MATH 3134	Applied Combinatorics and Graph Theory	3
Professional Writing Elective		3
Pathways		3
	Credits	**15**
Spring Semester		
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
Data-Centric Computing Elective [3]		3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**15**
Fourth Year		
Fall Semester		
CS 3314	Programming Language Theory and Practice	3
CS Technical Elective [3]		3
Data-Centric Computing Elective [3]		3
Data-Centric Computing Elective [3]		3
Free Elective		3
	Credits	**15**
Spring Semester		
CS 4944	Seminar	1
CS 3/4/5XXX	Elective [3]	3
CS 4XXX	Data-Centric Computing Capstone	3
Data-Centric Computing Elective [3]		3
Pathways 2, 3, 6a, or 7		3
Free Elective		1
	Credits	**14**
	Total Credits	**123**

Secure Computing Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CS 1114	Introduction to Software Design (C)	3
CS 2505	Introduction to Computer Organization (C)	3
CS 2506	Introduction to Computer Organization (C)	3
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus Integrated Quantitative Sciences	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics Introduction to Proofs	3
Subtotal		24
Major Requirements		
CS/BIT/PSCI 2164	Foundations of Contemporary Security Environments	3
CS 3314	Programming Language Theory and Practice	3
CS 4264	Principles of Computer Security	3
CS 4XXX	Secure Computing Capstone	3
Secure Computing Electives [3]		9
Subtotal		21
Additional Course Requirements		
CS 1944	Computer Science First Year Seminar	1
CS 2114	Software Design and Data Structures (C)	3
CS 4944	Seminar	1
MATH 3134	Applied Combinatorics and Graph Theory	3

or MATH 3124	Modern Algebra	
Subtotal		8
Elective Courses		
CS 3/4/5XXX Elective [3]		3
CS Technical Elective [3]		3
Advanced Natural Science Elective		4
Communications Elective		3
Professional Writing Elective		3
Statistics Elective		3
Free Electives		4
Subtotal		23
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (use Communications Elective, Professional Writing Elective, or Free Elective)		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Natural Science Elective		4
Natural Science Elective		4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
CS 3114	Data Structures and Algorithms (5A ; C)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 should be double counted with another core concept. In this case, additional free elective credits must be taken to maintain a minimum of 123 credits.		3
Subtotal		47
Total Credits		**123**

Additional Requirements and Notes

Minor Restriction: students pursing a Major in Secure Computing may not minor in Cybersecurity.

Secure Computing Electives

Note: Some elective courses may include prerequisites not required by this checksheet. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

1. **Natural Science Electives:** Choose 8 credits

Code	Title	Credits
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory	4
PHYS 2305	Foundations of Physics	4

2. **Advanced Natural Science Elective:** Choose 4 credits

Code	Title	Credits
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory	4
PHYS 2306	Foundations of Physics	4

3. **Communications Elective.** Students must take one of the following:

Code	Title	Credits
COMM 2004	Public Speaking	3
COMM 2014	Speech Communication	3

Note: COMM 2004 Public Speaking can be used to satisfy Pathways 1A. Students who do not take COMM 2004 Public Speaking as their communications elective will need to satisfy Pathways 1A through a suitable professional writing elective or free elective.

4. **Professional Writing Elective.** Students must take one of the following:

Code	Title	Credits
ENGL 3764	Technical Writing	3
ENGL 3804	Technical Editing and Style	3
ENGL 3814	Creating User Documentation	3
ENGL 3824	Visual Rhetoric and Document Design	3
ENGL 3834	Intercultural Issues in Professional Writing	3
ENGL 3844	Writing and Digital Media	3
ENGL 4824	Science Writing	3

Note: ENGL 3764 Technical Writing can be used to satisfy Pathways 1A. Students who do not take ENGL 3764 Technical Writing as their communications elective will need to satisfy Pathways 1A through a suitable communications elective or free elective.

5. **Statistics Elective.** Students must take one of the following:

Code	Title	Credits
STAT 4705	Probability and Statistics for Engineers	3
STAT 4105	Theoretical Statistics	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
STAT 4604	Statistical Methods for Engineers	3
STAT 3704	Statistics for Engineering Applications	2
CMDA 2006	Integrated Quantitative Sciences	6

Note: Students taking STAT 3704 Statistics for Engineering Applications must take an additional 1 free elective credit to meet the

total number of credits required for the degree. Students considering a possible change of major to Data-Centric Computing should take one of STAT 4705 Probability and Statistics for Engineers, STAT 4105 Theoretical Statistics, or CMDA 2006 Integrated Quantitative Sciences, since that major uses a more restrictive list of statistics electives.

6. **CS 3/4/5XXXX Electives[3].** Other than the exceptions listed below, any 3-credit CS 3/4/5000-level course not otherwise used to fulfill a Computer Science requirement can be used as a CS 3/4/5XXX elective, including both and . Additionally, the following cross-listed courses are allowed for CS 3/4/5XXX elective credit.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynamics	3
ART 3704	Topics in Computer Animation	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4514		3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4644	Artificial Intelligence for Design, Construction, and Operations	3
CMDA 3606	Mathematical Modeling: Methods and Tools	3
ECE 3544	Digital Design I	4
ECE 3574	Applied Software Design	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4550	Real-Time Systems	3
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964	Field Study	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG 4314	Spatial Analysis in Geographic Information Systems	3
GEOG 4324	Algorithms in Geographic Information Systems	4
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4454	Applied Mathematical Modeling	3
ME 4524	Introduction to Robotics and Automation	3
MUS 3064	Digital Sound Manipulation	3
MUS 3065	Computer Music and Multimedia Design	3
MUS 3066	Computer Music and Multimedia Design	3
PHYS 4755	Introduction to Computational Physics	3

Exceptions (not allowed to count towards CS 3/4/5XXX electives)

Code	Title	Credits
ENGL 3764	Technical Writing	3
ENGL 3804	Technical Editing and Style	3
ENGL 3814	Creating User Documentation	3
ENGL 3824	Visual Rhetoric and Document Design	3
ENGL 3834	Intercultural Issues in Professional Writing	3
ENGL 3844	Writing and Digital Media	3
ENGL 4824	Science Writing	3

7. **Secure Computing Elective[3].** Students must take three of the following:

Code	Title	Credits
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CS 3274	Software Reverse Engineering	3
CS 3754	Cloud Software Development	3
CS 4254	Computer Network Architecture and Programming	3
ECE 4560	Computer and Network Security Fundamentals	3
FIN 4014	Cyberlaw and Policy	3
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
CS 5264	Advanced Linux Kernel Programming	3
CS 5580	Cryptographic Engineering	3
CS 5584	Network Security	3
CS 5590	System and Software Security	3
CS 5594	Blockchain Technologies	3

8. **Secure Computing Capstone Requirement.** Students must complete one 4000-level CS capstone course in the secure computing area. Students may choose the course listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the secure computing capstone requirement.

Code	Title	Credits
CS 4284	Systems & Networking Capstone	3
CS 4274	Secure Computing Capstone	3

With prior departmental approval, ENGE 4735 Interdisciplinary Design Capstone or ENGE 4736 Interdisciplinary Design Capstone can fulfill the capstone requirement in semesters where the course includes a significant software security aspect.

9. **CS Technical Elective[3].** Secure Computing majors must satisfy a 3 credit hour technical elective requirement by taking one of:
   a. Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (6) above.
   b. Any Secure Computing Elective listed under (6) above that is not otherwise used to fulfill a Secure Computing requirement.
   c. Any approved 3000- or 4000-level course in another discipline that has significant technical content relevant to the science or application of computer science can be used as a technical elective.

i. Requests to have a non-CS course approved as a technical elective are made by submitting a course syllabus to your CS advisor for review prior to enrolling in the course. This includes non-CS Independent Study (4974) and Undergraduate Research (4994) courses.

ii. Below is a listing of non-CS courses that are approved as technical electives.
Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

Code	Title	Credits
AOE 4434	Introduction to Computational Fluid Dynamics	3
ART 3704	Topics in Computer Animation	3
BIT 4424	Business Information Visualization and Analytics	3
BIT 4434	Computer Simulation in Business	3
BIT 4444	Web-Based Decision Support Systems	3
BIT 4514		3
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT	3
BIT 4604	Data Governance, Privacy and Ethics	3
BIT 4614	Cybersecurity Management II	3
BIT 4624	Cybersecurity Analytics for Business	3
CEM 4624	Construction Robotics and Automation	3
CEM 4644	Artificial Intelligence for Design, Construction, and Operations	3
CMDA 3606	Mathematical Modeling: Methods and Tools	3
ECE 3544	Digital Design I	4
ECE 3574	Applied Software Design	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4550	Real-Time Systems	3
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
ENGE 4735	Interdisciplinary Design Capstone	3
ENGE 4736	Interdisciplinary Design Capstone	3
ENGE 4964	Field Study	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
GEOG 4314	Spatial Analysis in Geographic Information Systems	3
GEOG 4324	Algorithms in Geographic Information Systems	4
MATH 4175	Cryptography	3
MATH 4176	Cryptography	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4454	Applied Mathematical Modeling	3
ME 4524	Introduction to Robotics and Automation	3
MUS 3064	Digital Sound Manipulation	3
MUS 3065	Computer Music and Multimedia Design	3
MUS 3066	Computer Music and Multimedia Design	3
PHYS 4755	Introduction to Computational Physics	3

[1] **CS Non-Technical Course Requirement.** B.S. in CS students must complete 30 credits of non-technical courses. All courses are approved as non-technical courses except those in the departments of Biological Sciences, Chemistry, Geosciences, Physics, Mathematics, and Statistics, and all departments in the College of Engineering, except for engineering courses satisfying Pathways 7. Also excluded are courses listed as CS technical electives.

[2] **Independent Study/Undergraduate Research.** No more than a total of 6 credits of CS 4974 Independent Study and/or CS 4994 Undergraduate Research may be used to fulfill CS degree requirements. To take Independent Study (CS 2974 Independent Study or CS 4974 Independent Study), a minimum overall and in-major GPA of 2.5 is required. To take Undergraduate Research (CS 4994 Undergraduate Research), a minimum overall GPA of 2.5 and an in-major GPA of 3.0 is required. CS 4974 Independent Study and CS 4994 Undergraduate Research also require completion of CS 3114 Data Structures and Algorithms with a grade of **C** or better.

[3] **Undergraduates Taking Graduate Courses**. Students within 2 semesters of graduating and with a 3.0 or better GPA may enroll in 5000-level courses satisfying undergraduate degree requirements within their department if they have been accepted into the Accelerated Undergraduate/Graduate Program, or by permission of the course instructor and the Department. For students not accepted into the Accelerated Undergraduate/Graduate Program, these courses may not be used on the Plan of Study for a graduate degree.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CS Department fully supports this policy. Specific expectations for satisfactory progress for Computer Science majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog: http://www.undergradcatalog.registrar.vt.edu/1920/academic-policies.html#22
- Be registered in at least one 3-credit course **required** in the major during each on-campus semester of the regular academic year.
- Maintain an in-major GPA of 2.0 or better (calculated using all classes with a CS designator).
- Not take any CS course required in the major more than twice, including attempts ending in course withdrawal.
- Not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

Graduation Requirements

To qualify for a B.S. degree in CS, a student must:

1. Completed at least 123 credit hours
2. Earn a “C” (2.0) or better in CS 1114 Introduction to Software Design, CS 2114 Software Design and Data Structures, CS 2505 Introduction to Computer Organization, CS 2506 Introduction to Computer Organization and CS 3114 Data Structures and Algorithms.

3. Earn a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00 (the in-major GPA is calculated using all classes with a CS designator).

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + free elective (4 cr)
3. CS 2064 (C) may be substituted for CS 1114 (C)
4. ECE 2514 (C) may be substituted for CS 1114 (C)
5. ECE 3514 (C) may be substituted for CS 2114 (C)
6. ECE 2564 (C) may be substituted for CS 2505 (C)

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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Roadmap

First Year		
Fall Semester		**Credits**
CS 1114	Introduction to Software Design (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Natural Science Elective		4
	Credits	**16**
Spring Semester		
CS 2114	Software Design and Data Structures (C)	3
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
Natural Science Elective		4
	Credits	**16**
Second Year		
Fall Semester		
CS 1944	Computer Science First Year Seminar	1
CS/BIT/PSCI 2164	Foundations of Contemporary Security Environments	3
CS 2505	Introduction to Computer Organization (C)	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**16**
Spring Semester		
CS 2506	Introduction to Computer Organization (C)	3
MATH 2204 or CMDA 2005	Introduction to Multivariable Calculus or Integrated Quantitative Sciences	3
MATH 2114	Introduction to Linear Algebra	3
Communications Elective		3
Advanced Natural Science Elective		4
	Credits	**16**
Third Year		
Fall Semester		
CS 3114	Data Structures and Algorithms (C)	3
MATH 3134	Applied Combinatorics and Graph Theory	3
Secure Computing Elective [3]		3
Professional Writing Elective		3
Pathways 2, 3, 6a, or 7		3
	Credits	**15**
Spring Semester		
CS 3214	Computer Systems	3
CS 3604	Professionalism in Computing	3
Statistics Elective		3
Pathways 2, 3, 6a, or 7		3
Pathways 2, 3, 6a, or 7		3
	Credits	**15**
Fourth Year		
Fall Semester		
CS 3314	Programming Language Theory and Practice	3
CS 4264	Principles of Computer Security	3
CS Technical Elective [3]		3
Secure Computing Elective [3]		3
Free Elective		3
	Credits	**15**
Spring Semester		
CS 4944	Seminar	1
CS 4XXX: Secure Computing Capstone		3
Secure Computing Elective [3]		3
CS 3/4/5XXX Elective [3]		3
Pathways 2, 3, 6a, or 7		3
Free Elective		1
	Credits	**14**
	Total Credits	**123**

Electrical and Computer Engineering

Our Website (http://www.ece.vt.edu)

Overview

The Bradley Department of Electrical and Computer Engineering (ECE) offers bachelor of science degrees in electrical engineering (EE) and computer engineering (CPE). A key competitive advantage offered to undergraduate students in the department is the ability of students to pursue one of twelve different majors. This is possible since the department is one of the largest ECE departments in the U.S. with faculty expertise across the spectrum of electrical and computer engineering.

Traditional electrical and computer engineering programs consist of five basic areas: electricity (e.g. power systems), electronics, electromagnetics, hardware, and software. Graduates today apply their degree in more varied careers from investment banks to NGOs to medical firms. Instead of pushing student onto a single path, the department model allows students to choose the course of study that reflects their personal goals. Students have the flexibility to make conscious choices about what to do next at every stage of their journey.

All students in the department go through a seven-course base curriculum during their second year and then branch into their choice of major. This approach reflects today's reality that the electrical and computer engineers create technology that is transforming modern life – from transportation, agriculture, and manufacturing, to healthcare, education, entertainment, and social interactions. Students pursuing an electrical engineering degree can select a major from Controls, Robotics & Autonomy, Wireless Communications & Signal Processing, Energy & Power Electronic Systems, Micro/Nanosystems, and Applied Electromagnetics. Students pursuing a computer engineering degree can

select a major from Chip-Scale Integration, Machine Learning, Networking & Cybersecurity, Software Systems, or Controls, Robotics & Autonomy. If a student prefers a less focused approach they can still pursue a general electrical engineering major or a general computer engineering major.

In addition to undergraduate degrees, the department also offers M.S., M.Eng., and Ph.D. programs in both EE and CPE. An accelerated undergraduate/graduate (UG/G) program is available for qualified undergraduates.

Electrical engineers (EEs) and computer engineers (CPEs) create important and exciting technologies, systems and applications that make the world a better place for all of us. EEs and CPEs are inventing new ways to generate, distribute and use electric power that are more efficient, more sustainable and friendlier to the environment. For example, wider use of solar energy relies on improved photovoltaic devices, power electronics for energy conversion, and power grids. Some of our most critical global infrastructures, including the Internet, mobile voice and data networks, and the electric power grid are designed by EEs and CPEs. And, EEs and CPEs design sensors and embedded systems to monitor intelligent buildings and transportation systems. Applying innovative technologies to biology and the healthcare industry, EEs and CPEs create techniques for medical imaging, micro-electromechanical systems for medical diagnostics, implantable devices for health monitoring and drug delivery, and information systems to improve healthcare delivery. To meet the challenge of cybersecurity, EEs and CPEs design hardware and software for cryptographic algorithms and develop methods to ensure private communications through the Internet and wireless devices. They design new devices and systems for high-performance computing and networking. They build satellites and instruments to improve communications and enhance our knowledge of space and the Earth. And, EEs and CPEs enhance our leisure time by creating new ways to listen to music, watch movies, play games, communicate with friends, and build social networks.

Students in the Bradley Department of Electrical and Computer Engineering learn from faculty who work at the cutting-edge of engineering research and bring the excitement of their discoveries to the classroom. Engineers want to make things that work. EE and CPE students get hands-on opportunities to build components and systems from the beginning of their studies. In the freshman year, students explore applications of electrical and computer engineering, such as medical imaging and cryptography. In the sophomore year, EE and CPE students use personal, portable equipment and components to build and explore simple digital and analog electronic systems, which become more complex each semester. Laboratories and team projects throughout the curriculum contribute to an enriching hands-on, minds-on learning experience. During their senior year, students participate in a team-based, industry-sponsored design project that spans two semesters in which they solve real-world engineering problems while learning project management and team-building skills.

Electrical engineering and computer engineering are dynamic and fast changing fields that drive innovation and solutions to global challenges. The ECE faculty has created a program of study that provides each graduate with a firm foundation in mathematics, physics, and engineering principles, and with broad experience in different areas of EE and CPE. The program enables our graduates to excel in their EE and CPE majors, while gaining the tools to adapt to the technical changes and career opportunities they will experience in the future. EE and CPE students develop effective communication and teamwork skills and gain knowledge of ethics, all of which are essential to professional success. EE and CPE graduates are prepared to pursue careers in industry and government, advanced graduate work in EE and CPE, and other advanced professional degrees.

ECE seeks to develop tomorrow's engineering and technical leaders and innovators. Students can enhance their undergraduate experience by participating in multidisciplinary team projects, cooperative education and internships, research experiences for undergraduates, study abroad programs, dual degree and minor programs in other fields, and mentoring programs. The Cooperative Education (co-op) and Internship Program is highly recommended, as is participation in professional societies, including the Institute of Electrical and Electronics Engineers (IEEE), Eta Kappa Nu (HKN), and the Association for Computing Machinery (ACM). ECE works with the Ted and Karyn Hume Center for National Security and Technology to develop future leaders for the US government. ECE offers many scholarships for academic excellence, leadership and service, as well as for participation in various special academic programs.

Accreditation, Program Educational Objectives, and Student Outcomes

The BS in **Computer Engineering** degree program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs.

The BS in **Electrical Engineering** degree program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Electrical, Computer, Communications, Telecommunication(s) and Similarly Named Engineering Programs.

Program Educational Objectives

The electrical and computer engineering programs integrate a strong and broad technical education with experiential learning and engineering professionalism training to provide our graduates the necessary knowledge and skills to solve complex 21st century problems. Within a few years of graduation, graduates from either of these programs will be:

- Advancing knowledge and making significant contributions to a variety of constituencies
- Seeking advanced degrees and life-long learning opportunities to maximize their contributions to society
- Emerging as entrepreneurs, researchers, or innovators in multi-disciplinary domains
- Contributing value to their employers and communities as conscientious and ethical professionals

Student Outcomes

Both the electrical engineering and the computer engineering program seek the same outcomes for students by the time they attain their BS degree. Upon graduation EE and CPE students will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.

4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

- Applied Electromagnetics Major (p. 855)
- Chip-Scale Integration Major (p. 858)
- Computer Engineering Major (p. 861)
- Controls, Robotics & Autonomy Major (p. 864)
- Controls, Robotics & Autonomy Major (p. 866)
- Electrical Engineering Major (p. 869)
- Energy & Power Electronic Systems Major (p. 872)
- Machine Learning Major (p. 874)
- Micro/Nanosystems Major (p. 877)
- Networking & Cybersecurity Major (p. 880)
- Software Systems Major (p. 882)
- Wireless Communications and Signal Processing Major (p. 885)

Head and Roanoke Electric Steel Professor in Engineering: Luke F. Lester
University Distinguished Professor: D. Boroyevich
University Distinguished Professor Emeritus: A. G. Phadke and F. C. Lee
Alumni Distinguished Professor Emeritus: C. W. Bostian
Bradley Distinguished Professor Emeritus of Electromagnetics: G. S. Brown
Thomas Phillips Professor Emeritus: W. L. Stutzman
American Electric Power Professor: Chen-Ching Liu
Clayton Ayre Professor: A. Wang
Hugh P. and Ethel C. Kelly Professor: R. Zhang
Joseph R. Loring Professor in ECE: S. Rahman
Willis G. Worcester Professor in ECE: J. H. Reed
Virginia Microelectronics Consortium Professor: M. Agah
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J. Byron Maupin Professor: W. A. Scales

W Martin Johnson Professorship: H. Dhillon
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Assistant Professors: J Budhu, C. DiMarino, T. Doan, R. Jia, M. Jin, Z Lin, E. Lind, L. Shao, and W. Xiong.
Collegiate Professors: S. Dunning, C. Jones, and T. Talty,
Collegiate Associate Professors: W J Adams, D P Connors, K. L. Cooper, S. Ransbottom, A Soysal, and N. Tryfona
Collegiate Assistant Professors: A. H. Ball, A. M. Boker, K. Giles, S. Ha, M. Lanzerotti, and R. Raghunathan
Adjunct Professors of Practice: D. M. Sable, E. Meadows, and K. R. Schulz
Assistant Professors of Practice: P. Han
Advanced Instructors: J. Thweatt
Instructors: Tyler Milburn, A. Sarker, and S. Yu

Undergraduate Course Descriptions (ECE)

ECE 1004 - Introduction to ECE Concepts (3 credits)
Introduction to topics that span the field of electrical and computer engineering (ECE). Content presented through the lens of application with accompanying hands-on exercises. Basics of circuits, op-amps, power supplies, computer logic, system decomposition, and coding. Modeling and application of engineering professionalism. Exploration of ECE in society.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2024 - Circuits and Devices (3 credits)
Analysis and design of passive and active circuits under Direct Current (DC), Alternating Current (AC), and switched excitation. Linear circuit analysis techniques for various circuit topologies. Expressing the transient response of first- and second-order linear circuits using time-domain methods. Calculating the AC steady-state response of linear circuits using phasors and immittances. Characterizing the frequency response of linear circuits. Determining operating point and small signal response of non-linear circuits containing diodes and bipolar transistors. Projects demonstrating circuit design processes adhering to professional practices.
Prerequisite(s): ECE 1004 and (MATH 2114 or MATH 2114H or MATH 2405H)
Corequisite(s): MATH 2214, PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2054 - Applied Electrical Theory (3 credits)
For students in the Mechanical Engineering program or by permission of the ECE Department. Fundamentals of electric circuits; circuit laws and network theorems, operational amplifiers, energy storage elements, response of first and second order systems, AC steady state analysis. Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ECE 2164 - Exploration of the Space Environment (3 credits)
This introductory course covers a broad range of scientific, engineering, and societal aspects associated with the exploration and technological exploitation of space. Topics covered include: science of the space environment; space weather hazards and societal impacts; orbital mechanics and rocket propulsion; spacecraft subsystems; applications of space-based technologies.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 2664

ECE 2214 - Physical Electronics (3 credits)
Fundamentals of electrostatics and magnetostatics, transmission lines, impedance matching networks, electromagnetic (EM) waves, and basic operating principles of diodes and metal-oxide semiconductor field-effect transistors (MOSFETs). Designing MOSFET biasing, and single-ended and differential amplifier circuits. Basic operating principles of complementary metal-oxide semiconductor (CMOS) device and its application as a digital inverter. Electronic circuit design adhering to professional and ethical practices.
Prerequisite(s): ECE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2274 - Electronic Networks Laboratory I (1 credit)
Principles of operation of electrical and electronic test equipment and applications to measurement of circuit parameters. Transient and steady state response of RLC networks. Applications of laws and theories of circuits. Design, prototyping, and testing of electronic devices and circuits. Must have C- or better in prerequisite.
Prerequisite(s): ECE 2074
Corequisite(s): ECE 2204
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 2514 - Computational Engineering (3 credits)
Software development processes for electrical and computer engineering applications. Modeling, simulation, data analysis, and visualization. Computing abstractions and the use of application programming interfaces. Software design and implementation using a procedural, class-based language. Integrated code development and testing. Team-based development of autonomous system applications reinforcing course topics.
Prerequisite(s): ECE 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2544 - Fundamentals of Digital Systems (3 credits)
Design and analysis of digital systems. Information representations and computer arithmetic. Switch and gate design within digital logic. Combinational logic analysis and synthesis, Hardware Description Languages (HDL), and hierarchical design. Finite-state machines, synchronous sequential logic analysis and design. Hardware specification and documentation. Register transfer level architectures, computer organization, memories, and digital interfacing. Instruction set architecture and assembly language programming. Emphasis on the relationship between software and hardware.
Prerequisite(s): ECE 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2564 - Embedded Systems (3 credits)
Use of microcontroller-based embedded systems as a tool to address digital control and sensing in engineering applications. Modern methodologies for programming microcontrollers including programming under real-time and resource design constraints. Finite-state machine modeling and software implementation. Event-driven programming including polling-based and interrupt-driven input/output. Integration of sensors and actuators, use of standard digital and analog interfaces, and use of hardware peripherals in microcontroller architectures. Design of hardware abstraction layers and software architectures for embedded systems. Integration of hardware peripherals into real-time, software applications. Software toolchains for embedded systems, use of debugger and development and testing methodologies. Professional project management and version control.
Prerequisite(s): ECE 2514 and ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2714 - Signals and Systems (3 credits)
Mathematical methods for the analysis and design of continuous and discrete linear, time-invariant systems. Representation of signals using time-domain and frequency-domain methods and the application of Fourier transforms to linear system design and analysis. Descriptions of systems as signal transformations using block diagrams, differential equations, difference equations, convolution, and transfer functions. Applications to signal filtering, measurement, and control of the physical devices. Formal project documentation adhering to professional practices.
Prerequisite(s): ECE 2024 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 2804 - Integrated Design Project (2 credits)
Design, implementation, testing, and validation of a hardware and software solution to an open-ended engineering problem integrating both analog and digital components. Using industrial-caliber test and measurement equipment including: oscilloscopes, function generators, power supplies, and digital multi-meters. Technical documentation and oral presentation of design process and solution. Overview of the scope of the electrical and computer engineering profession and issues related to its societal impact and ethical considerations.
Prerequisite(s): ECE 2024 and ECE 2514 and ECE 2544
Corequisite(s): ECE 2214 and (ECE 2564 or ECE 2714)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ECE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 2974 - Independent Study (1-19 credits)
A minimum GPA of 2.0 in all ECE courses is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3004 - AC Circuit Analysis (3 credits)
Application of the basic laws and techniques of circuit analysis to AC circuits. Complex numbers and algebra with an emphasis on phasor representation of circuits. Calculation of the frequency response of circuits with R, L, and C components, independent sources, controlled sources, and operational amplifiers. Analysis of AC steady-state circuits and determination of average power. Magnetically coupled circuits. Laplace and Fourier transforms. Representation of circuits by two-port models. C- or better in prerequisites.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3054 - Electrical Theory (3 credits)
For students in curricula other than ECE or ME. Fundamentals of electric circuits and electronic devices. Fundamentals of electric circuits: circuit laws and network theorems, operational amplifiers, energy storage elements, response of first (Resistive-Inductive RL, and Resistive Capacitive RC) and second order (Resistive-Inductive-Capacitive RLC) systems, Alternating Current (AC) steady state analysis. Basic electronic devices: Diodes and Transistors.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3074 - AC Circuit Analysis Laboratory (1 credit)
Construction, analysis, and characterization of circuits with student-owned Lab-in-a-Box system. Experiments include: sinusoids and phasors including impedance, admittance, and Kirchhoffs laws; sinusoidal steady- state including node and mesh analysis, Thevenin and Norton equivalent, and op amps; ac power analysis including instantaneous and average power, power factor, and complex power; magnetically coupled circuits including mutual inductance, energy in a coupled circuit, and transformers; frequency response including transfer functions, Bode plots, resonance, and passive and active filters; and two-port circuits. A C- or better is required for all prerequisites.
Prerequisite(s): ECE 2804
Corequisite(s): ECE 3004
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3104 - Introduction to Space Systems and Technologies (3 credits)
Introduction to technologies and computational tools used in space-based applications, including techniques for exploring the planets and the near-Earth geospace environment. Overview of orbits, spacecraft, control of spacecraft, electromechanical system requirements for space-based applications, and space environment interactions with spacecraft systems. Understanding the space environment and the engineering approaches required to operate it. A C- or better is required in prerequisites.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3105 - Electromagnetic Fields (3 credits)
Maxwells equations and their application to engineering problems. ECE 3105: transmission lines, introductory electrostatics, introductory magnetostatics, Faradays Law, properties of uniform plane waves. ECE 3106: electrostatics and magnetostatics, Maxwells Equations, wave propagation in uniform media, the reflection and transmission of plane waves, guided waves, radiation. A C- or better is required in the prerequisites.
Prerequisite(s): ECE 2214 and (MATH 2204 or MATH 2204H or MATH 2406H) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3106 - Electromagnetic Fields (3 credits)
Maxwells equations and their application to engineering problems. ECE 3105: transmission lines, introductory electrostatics, introductory magnetostatics, Faradays Law, properties of uniform plane waves. ECE 3106: electrostatics and magnetostatics, Maxwells Equations, wave propagation in uniform media, the reflection and transmission of plane waves, guided waves, radiation. A C- or better is required in the prerequisites.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3134 - Introduction to Optoelectronics (3 credits)
Fundamental principles of optoelectronics. The concept of photons, spontaneous emission, and simulated emission. Rate equation analysis of light emitting diodes and lasers. Operation principles and device characteristics of photodetectors and solar cells. Advanced topics such as quantum well and emerging materials.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3154 - Space Systems - Design and Validation (2 credits)
Introduction to systems and techniques used in electrical engineering design for space-based applications. Students design, fabricate, and test an electronic system following accepted NASA and industry standards, including functional bench-top tests, thermal testing, vibration testing, and long-duration operational testing. Periodic formal reports will document design approaches and test results.
Prerequisite(s): ECE 3105
Corequisite(s): ECE 3104
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ECE 3174 - Optoelectronics Laboratory (1 credit)
Characterization of optoelectronic devices such as light emitting diodes, semiconductor lasers, and photodetectors. Characterization and analysis of optical interference, wave propogation in optical fibers, and optical diffraction. Construction of simple optical imaging systems using lenses and bulk optics.
Prerequisite(s): ECE 2804
Corequisite(s): ECE 3134
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3204 - Analog Electronics (3 credits)
Small signal modeling of transistors. Basic architecture and functionality of linear amplifiers including transistor biasing circuits, current sources, differential amplifier, common emitter amplifier, common source amplifier, emitter follower, source follower, common base amplifier, and common gate amplifier. Frequency response of single stage and multistage amplifiers.
Prerequisite(s): ECE 2214 and ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3214 - Semiconductor Device Fundamentals (3 credits)
Fundamental semiconductor device physics associated with intrinsic and doped semiconductor materials, drift-diffusion of charge carriers, and devices with an in-depth coverage of p-n and Schottky diodes, bipolar junction transistors, and metal-oxide semiconductor and junction field effect transistors.
Prerequisite(s): ECE 2214 or MSE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3254 - Industrial Electronics (3 credits)
Fundamentals of electronics, including basic device principles. Include digital, operational amplifier, and analog analysis for industrial applications and magnetic circuits. For students in the Mechanical Engineering program or by permission of the ECE Department.
Prerequisite(s): ECE 2054
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

ECE 3274 - Electronic Circuits Laboratory II (1 credit)
Design, build, and test amplifiers and other electronic circuits to meet specifications. Bipolar and field-effect transistors, diodes, integrated circuits such as operational amplifiers, and passive components are used. Gain, bandwidth, input and output impedance, positive and negative feedback, and circuit stability are implemented in the designs. Digital oscilloscopes, ammeters, voltmeters, function generators, and power supplies are used. A grade of C- or better is required in all pre-requisite courses.
Prerequisite(s): ECE 3074
Corequisite(s): ECE 3204
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3304 - Introduction to Power Systems (3 credits)
Basic concepts of AC systems, single-phase and three-phase networks, electric power generation, transformers, transmission lines, electric machinery and the use of power. Pre-requisite 3004 with C- or better.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3354 - Electric Power Engineering Laboratory (1 credit)
Laboratory experiments based on principles of electric power engineering.
Corequisite(s): ECE 3304
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 3504 - Principles of Computer Architecture (3 credits)
Instruction formats and construction. Addressing modes. Memory hierarchy (cache, main memory and secondary memory) operation and performance. Simple pipelines. Basic performance analysis. Simple Operating System (OS) functions, particularly as they relate to hardware. Virtual memory. Computer Input/Output (I/O) concepts, including interrupt and Direct Memory Access (DMA) mechanisms. Intercomputer communication concepts. Processor design.
Prerequisite(s): ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3514 - Data Structures & Algorithms (3 credits)
Introduction of fundamental data structures, algorithms, and abstract data types. Data structures, arrays, linked lists, stacks, queues, and trees. Algorithms for manipulation, sorting, searching. Tree traversals. Implementation of data structures and algorithms in C++ using good design practices.
Prerequisite(s): ECE 2514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3524 - Introduction to Unix for ECE (2 credits)
Fundamental concepts of operating systems, emphasizing a hands-on introduction to Unix. User interfaces, Unix shell commands, the Unix file system, task management, common system utilities, the Unix programming environment. Students gain experience with system installation and administration.
Prerequisite(s): ECE 2804
Instructional Contact Hours: (2 Lec, 2 Crd)

ECE 3544 - Digital Design I (4 credits)
Design techniques for combinational and sequential logic. Design of digital circuits using standard integrated circuit chips and programmable logic devices. Computer simulation will be used to validate designs. Prototypes will be constructed to demonstrate design functionality.
Prerequisite(s): ECE 2544
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 3564 - Introduction to Computer Networking (3 credits)
Introduction to computer networking featuring the Internet. Internet architecture and layering. Application layer service models and protocols. Transport layer protocols and congestion control. Internet addressing, routing algorithms and protocols. Multiple access and link layer addressing, wireless local area networks (LANs) and cellular networks.
Prerequisite(s): ECE 2544 and ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3574 - Applied Software Design (3 credits)
An introduction to applied software design methods for use in the writing of efficient, reusable, and modular C++ programs. Introduces the use of the following: classes, inheritance, and polymorphism; design patterns; high-level programming techniques using libraries, generics, and containers; widgets, models, and views; software frameworks for embedded systems; and advanced techniques ranging from multi-threading to reflective programming.
Prerequisite(s): ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3604 - Introduction to RF and Microwave Engineering (3 credits)
Introduction to circuits, devices, and systems for radio frequency (RF) and microwave applications. Fundamentals of antennas, propagation, small signal and power amplifiers, frequency conversion, and frequency synthesis. Tools and concepts including s-parameters, design impedance matching, dynamic range, noise figure, and link budget.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3614 - Introduction to Communication Systems (3 credits)
Analysis and design of communication systems with an emphasis on digital communications based on time and frequency domain analysis. Fourier transform techniques, linear systems, and filtering are reviewed. Power and energy spectral density of communication signals. Sampling and quantization of analog signals. Baseband and binary bandpass digital modulation including line coding, pulse shaping, and both pulse and carrier modulation techniques. Wireless communication system concepts including link budgets and multiple access. Transmitter and receiver design concepts. Signal-to-noise ratio, bit error rate, and their relationship. Analog techniques such as Amplitude Modulation (AM) and Frequency Modulation (FM) radio will be reviewed for conceptual and comparative purposes.
Prerequisite(s): ECE 2714 and STAT 4714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3704 - Continuous and Discrete System Theory (3 credits)
Continuous- and discrete-time system theory. Block diagrams, feedback, and stability theory. Continuous-time stability, differential equations, Laplace-transforms, transfer functions. Discrete-time stability, difference equations, Z-transforms. Transfer functions and frequency response. Sampling of continuous systems and an introduction to control and filter design. Hands-on projects to illustrate and integrate the various continuous- and discrete-time concepts and tools.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3714 - Introduction to Control Systems (3 credits)
Introduction to the design of feedback compensation to improve the transient and steady-state performance of systems. Emphasis is on modeling, analysis and analog compensator design for single-input single-output systems. Modeling techniques, root locus analysis and design, the Nyquist criterion, and frequency domain compensation.
Prerequisite(s): ECE 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 4104 - Microwave and RF Engineering (4 credits)
Passive and active Radio Frequency and microwave components and circuits for wireless communications; transmission-line theory; planar transmission-lines and waveguides; S-parameters; resonators; power dividers and couplers; microwave filters; sources, detectors, and active devices; modern RF & microwave CAD; measurement techniques. C- or better in prerequisites.
Prerequisite(s): ECE 3106 and ECE 3204
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4114 - Antennas (3 credits)
Antenna fundamentals, analysis and design principles, and a survey of antenna types including: arrays, wire antennas, broadband antennas, and aperture antennas.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4124 - Radio Wave Propagation (3 credits)
Behavior of radiated electromagnetic waves in terrestrial, atmosphere, space, and urban environments; path, frequency and antenna selection for practical communication systems; propagation prediction.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4134 - Photonics (3 credits)
Fundamental concepts in photonics technology. Basic principles of optical fibers and components such as Bragg gratings, amplifiers, couplers and modulators used in optical communications and sensing. Propagation, dispersion, bandwidth and nonlinear properties of optical signals in optical waveguides and fibers.
Prerequisite(s): ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4144 - Optical Systems (3 credits)
Fundamental concepts in optical information processing. Ray optics. Optical diffraction. Basic principles and applications of optical imaging using wave optics. Properties of Gaussian Beam. Introduction to Fourier optics, optical spatial filtering, 3D image reconstruction and holography.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4154 - Space Weather: The Solar Wind and Magnetosphere (3 credits)
Solar-terrestrial interactions and space weather: the sun, solar wind, and interplanetary magnetic field; space plasma physics and magnetohydrodynamics; Earths magnetosphere and ionosphere; geomagnetic storms and auroral substorms; societal impacts of space weather; planetary magnetospheres; space science instrumentation.
Prerequisite(s): ECE 3105 or AOE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4654

ECE 4164 - Introduction to Global Positioning System (GPS) Theory and Design (4 credits)
Fundamental theory and applications of radio navigation with the Global Positioning System GPS. Satellite orbit theory, GPS signal structure and theory, point positioning with pseudoranges and carrier phases, selective availability, dilution of precision, differential GPS, atmospheric effects on GPS signals.
Prerequisite(s): ECE 3105 or AOE 4134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: AOE 4464

ECE 4174 - Upper Atmosphere/Ionosphere Space Weather (3 credits)
Interaction of Earth's upper atmosphere and space environment with spacecraft: processes that affect atmospheric density relevant to spacecraft orbit decay; basic composition and structure; radiation and radiative transfer; atmospheric energy balance; atmospheric chemistry and ion production/loss mechanisms; fundamental concepts of Solar-terrestrial physics including ionospheric Chapman theory; atmospheric energy/mass transport; ionospheric electrodynamics; ionospheric storms; planetary atmospheres/ionospheres; instrumentation.
Prerequisite(s): AOE 3014 or ECE 3105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4674

ECE 4184 - Applied Quantum Mechanics for Engineers (3 credits)
Review of classical mechanics, the simple harmonic oscillator. Schrodinger equation, barrier tunneling, resonant tunneling, and quantum wells. Mathematical foundation of quantum mechanics, Dirac notation and representations, observables, eigenstates and diagonalization. Quantum postulates and its application to two-level systems, harmonic oscillators, creation and annihilation operators. Time evolution of a Hamiltonian. Dynamics of spin and two-level atoms. No cloning theorem and the concept of entanglement.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4194 - Engineering Principles of Remote Sensing (3 credits)
Physical principles involved in remote sensing of Earths environment and their implementation in engineering systems: fundamentals of electromagnetic wave propagation, scattering by matter, effects of propagation media, passive and active systems, remote sensing platforms, data processing, systems integration, and introductory concepts important for the design and analysis of remote sensing engineering systems.
Prerequisite(s): ECE 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4205 - Electronic Circuit Design (3 credits)
Stability and response of feedback amplifier, wideband amplifiers, operational amplifier characteristics, waveform generators and wave shaping, nonlinear circuit applications, signal generators, and photolithography. Design of analog electronic circuits, circuit simulation, response characterization, and printed circuit construction. C- or better in prerequisites.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4206 - Electronic Circuit Design (3 credits)
Stability and response of feedback amplifier, wideband amplifiers, operational amplifier characteristics, waveform generators and wave shaping, nonlinear circuit applications, signal generators, and photolithography. Design of analog electronic circuits, circuit simulation, response characterization, and printed circuit construction. C- or better in prerequisites.
Prerequisite(s): ECE 4205
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4220 - Analog Integrated Circuit Design (3 credits)
Integrated circuit design in silicon bipolar, MOS (Metal-Oxide-Semiconductor), and BiCMOS (Bipolar Complementary Metal-Oxide-Semiconductor) technologies for communications, sensor, instrumentation, data conversion, and power management applications. Models for active devices in bipolar and MOS technologies; transistor-level amplifiers and output stages (amplifier classifications); transistor-level current mirrors and voltage reference generators, transistor-level operational amplifiers; transistor-level feedback circuits; noise and linearity; layout and simulation of analog integrated circuits with modern VLSI CAD (Very Large Scale Integration- Computer Aided Design) software.
Prerequisite(s): ECE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4224 - Power Electronics (3 credits)
Switching power converter operation and design; modeling of power converters; power components including power semiconductor devices, inductors, and transformers; control of power converters; select power converter topology for applications such as renewable energy, electric transportation, and telecommunications.
Prerequisite(s): ECE 3204 and ECE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4234 - Semiconductor Processing (3 credits)
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 4234

ECE 4244 - Intermediate Semiconductor Processing Laboratory (3 credits)
Design, layout, fabricate, and characterize microelectronic devices. Analyze test results to verify performance to the predetermined specifications. Required oral and written reports. A C- or higher is required in all pre-requisite courses.
Prerequisite(s): ECE 4234 or MSE 4234
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

ECE 4254 - Principles of Electronics Packaging (3 credits)
Electrical and thermal design of electronics packaging using finite element analysis software. Materials and process selection guidelines for the fabrication of single- and multi-chip electronics packages. Methods for characterization and testing of electronics packages. Failure mechanisms and design for reliability. Hands-on project experience on electronics packaging.
Prerequisite(s): ECE 2214 or ECE 2054 or ECE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4284 - Power Electronics Laboratory (1 credit)
Design and testing of electronic power processing systems for commercial and aerospace applications.
Corequisite(s): ECE 4224
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4314 - Electric Energy Distribution Systems (3 credits)
Fundamentals of electric power distribution systems. Load characteristics. Modeling of distribution system components (line segments, voltage regulators, and transformers). Distribution flow analysis. Capacitor placement. Symmetrical components and calculation of fault currents. Protection of distribution feeders. Automation/control technologies to enhance reliability, resilience, and security.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4324 - Microgrids (3 credits)
Microgrid: definitions, components, and modes of operation; steady-state analysis and power quality; control modes and hierarchy; renewable resources and their inverter grid-forming and grid-following modes; protection strategies; emerging topics e.g., DC microgrids and datacenters; cybersecurity.
Prerequisite(s): ECE 3004
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4334 - Power System Analysis and Control (3 credits)
Development of methods for power analysis and control. An analysis and design of systems for steady state, transient, and dynamic conditions. Digital solutions emphasized.
Prerequisite(s): ECE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4354 - Power System Protection (3 credits)
Protection of power apparatus and systems. Fuses. Voltage and current transducers. Relays. Coordination of relays. Pilot channels. Grounding practices. Surge phenomena. Insulation coordination.
Prerequisite(s): ECE 4334
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4364 - Alternate Energy Systems (3 credits)
Electric energy from alternative energy sources including solar, wind, hydro, biomass, geothermal and ocean. Characteristics of direct conversion, electromechanical conversion, and storage devices used in alternative energy systems. Power system issues associated with integration of small scale energy sources into the electricity grid.
Prerequisite(s): STAT 3704 or STAT 4604 or STAT 4705 or STAT 4714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4414 - Linux Kernel Programming (3 credits)
Design and internal organization of the Linux operating system kernel. Kernel subsystems, boot process, memory management, process and thread model, scheduling, interrupt and exception handling, virtual file system and the concrete file system, block I/O and I/O scheduler, network stack, and device drivers. Modification of existing kernel code. Design, implementation, test and evaluation of new kernel modules. Kernel and full software stack debugging techniques, and virtualization as an aid for operating system development and debug. Software engineering techniques to analyze, modify and run a large, complex open-source code base.
Prerequisite(s): ECE 3574 or CS 3114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4224

ECE 4424 - Machine Learning (3 credits)
Algorithms and principles involved in machine learning; focus on perception problems arising in computer vision, natural language processing and robotics; fundamentals of representing uncertainty, learning from data, supervised learning, ensemble methods, unsupervised learning, structured models, learning theory and reinforcement learning; design and analysis of machine perception systems; design and implementation of a technical project applied to real-world datasets (images, text, robotics). A grade of C- or better in prerequisites.
Prerequisite(s): (ECE 3514 or CS 2114) and (STAT 3704 or STAT 4105 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4824

ECE 4444 - Technological Singularity (3 credits)
True artificial machine intelligence. Societal impact. Historical perspectives. Technological barriers to whole brain emulation. Engineering of superintelligence. Role of consciousness. Cross disciplinary course for students with advanced technical backgrounds, e.g., seniors in engineering, math, physics, biology, or other similar disciplines.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4454 - Multimedia Signal Processing (3 credits)
Signal processing techniques in multimedia systems: concept and principle of multimedia systems; speech analysis and recognition; audio/image/video compression; scene video analysis & understanding; multimedia applications such as human computer interaction, multimedia communication and multimedia security.
Prerequisite(s): ECE 2704 or (ECE 2714 and ECE 2804)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4504 - Computer Organization (3 credits)
Overview of the structure, elements and analysis of modern enterprise computers. Performance evaluation of commercial computing. Past and emerging technology trends. Impact of parallelism at multiple levels of computer architecture. Memory and storage. Fundamental computer system descriptions, Amdahls Law, Flynns Taxonomy. A grade of C or better required in prerequisites.
Prerequisite(s): ECE 3504 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4504

ECE 4514 - Digital Design II (4 credits)
Advanced digital design techniques for developing complex digital circuits. Emphasis on system-level concepts and high-level design representations while meeting design constraints such as performance, power, and area. Methods presented that are appropriate for use with automated synthesis systems. Commercial hardware description language simulation and synthesis tools used for designing a series of increasingly complex digital systems, and implementing those systems using Field Programmable Gate Arrays (FPGAs).
Prerequisite(s): ECE 3544
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4520 - Digital and Mixed-Signal System Testing and Testable Design (3 credits)
Various topics on testing and testable design for digital and mixed-signal systems are studied: fault modeling, logic and fault simulation, fault modeling, automatic test pattern generation, deterministic ATPG, simulation-based ATPG, delay fault testing, design for testability, built-in-self-test and fault diagnosis.
Prerequisite(s): ECE 2574 and (ECE 3504 or ECE 3544)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4524 - Artificial Intelligence and Engineering Applications (4 credits)
Problem solving methods; problem spaces; search techniques; knowledge representation; programming languages for AI; games; predicate logic; knowledge-based systems; machine learning; planning techniques; reactive systems; artificial neural networks; natural language understanding; computer vision; robotics.
Prerequisite(s): ECE 3514 and STAT 4714
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4525 - Video Game Design and Engineering (3 credits)
4525: Fundamental concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video games. Game design and engineering principles, game architecture, game mechanics and interaction, computer graphics, strategy, artificial intelligence (AI), optimization, play testing and fuzzy logic are included. 4526: Advanced concepts in the development and engineering of modern 2-D and 3-D real-time interactive computer video systems. Topics include non-player character (NPC) behavior learning, search and planning, player modeling, procedural content generation, AI-assisted game design.
Prerequisite(s): ECE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4526 - Video Game Design and Engineering (3 credits)
Prerequisite(s): ECE 4525
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4530 - Hardware-Software Codesign (3 credits)
An introduction to the design of mixed hardware- software systems, focusing on common underlying modeling concepts, the design of hardware-software interfaces, and the trade-offs between hardware and software components. Students will use simulation tools to conduct experiments with mixed hardware- software systems in the area of embedded systems.
Prerequisite(s): (ECE 2534 or ECE 2564) and ECE 3544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4534 - Embedded System Design (4 credits)
Team-based major design experience. Design and implement embedded computer systems that incorporate appropriate engineering standards to solve complex problems that include multiple realistic constraints. Writing design documents and making oral presentations as part of the design process. C- or better required in prerequisites.
Prerequisite(s): (ECE 2014 and ECE 2534 and ECE 3574) or (ECE 2564 and ECE 2804 and ECE 3574)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ECE 4540 - VLSI Circuit Design (3 credits)
Introduction to the design and layout of Very Large Scale Integrated Circuits (VLSI). Emphasis is placed on digital CMOS circuits. Static and dynamic properties of MOSFET devices, along with integrated circuit fabrication are examined. Computer-aided design tools are used to produce working integrated circuit designs.
Prerequisite(s): ECE 2214 and ECE 2544
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4550 - Real-Time Systems (3 credits)
Theory, algorithmic and protocol concepts, mechanisms, and implementations of real-time computer systems. Introduction to real-time systems, real-time scheduling, real-time synchronization, real-time operating system kernels, and real-time resource management algorithms (e.g., scheduling, synchronization), their implementations in production operating system kernels, experimental studies of those implementations, and real-time application development.
Prerequisite(s): ECE 3574 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4554 - Introduction to Computer Vision (3 credits)
Techniques for automated analysis of images and videos. Image formation, detecting features in images, segmenting or grouping image regions and image features, multiple view geometry, object instance and category recognition in images and video processing.
Prerequisite(s): ECE 3574 and (STAT 4705 or STAT 4714)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4560 - Computer and Network Security Fundamentals (3 credits)
This course introduces fundamental security principles and real-world applications of Internet and computer security. Topics covered in the course include legal and privacy issues, risk analysis, attack and intrusion detection concepts, system log analysis, intrusion detection and packet filtering techniques, computer security models, computer forensics, and distributed denial-of-service (DDoS) attacks. Must have C- or better in ECE 4564 or CS 3214.
Prerequisite(s): ECE 3564 or CS 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4564 - Network Application Design (3 credits)
Application program interface and network transport services including User Datagram Protocol and Transmission Control Protocol from the Internet Protocol suite. Client-server organization and design of synchronous, asynchronous, and multithreaded client and server applications. Design, implementation, and testing techniques to improve robustness and performance. Partially duplicates CS 4254 and credit will not be allowed for both.
Prerequisite(s): ECE 3564 and ECE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4570 - Wireless Networks and Mobile Systems (3 credits)
Multidisciplinary, project-oriented design course that considers aspects of wireless and mobile systems including wireless networks and link protocols, mobile networking including support for the Internet Protocol suite, mobile middleware, and mobile applications. Students complete multiple experiments and design projects.
Prerequisite(s): ECE 4564
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4570

ECE 4574 - Large-Scale Software Development for Engineering Systems (3 credits)
Large-scale software implementations of the hierarchy of engineering analysis, design, and decision evaluation. Computer-aided engineering programs with state-of-the-art computer tools and methods. Operator overloading, dynamic polymorphism, graphical user interfaces, generic programming, dynamic link libraries, and multiple threads.
Prerequisite(s): ECE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4580 - Digital Image Processing (3 credits)
This course provides an introduction to basic concepts, methodologies and algorithms of digital image processing focusing on the two major problems concerned with digital images: (1) image analysis and object restoration for easier interpretation of images, and (2) image analysis and object recognition. Some advanced image processing techniques (e.g., wavelet and multiresolution processing) will also be studied in this course. The primary goal of this course is to lay a solid foundation for students to study advanced image analysis topics such as computer vision systems, biomedical image analysis, and multimedia processing & retrieval.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4584 - Robotics Laboratory (1 credit)
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and path planning.
Corequisite(s): ME 4524 or ECE 4704
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ME 4584

ECE 4605 - Radio Engineering (3 credits)
Wireless application circuit design for gain and filter control at radio frequencies to interface the baseband processing systems and the antennas of communication systems. 4605: Design of radio transmitter and receiver circuits using scattering-parameter methods. Circuits include oscillators, radio frequency amplifiers and matching networks, mixers and detectors. 4606: Design of amplitude, frequency, and pulse-modulated communication systems, including modulators, detectors, and the effects of noise. Design basics and guidelines for phase-locked loops and several power amplifier configurations.
Prerequisite(s): ECE 3105 and ECE 3204 and ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4606 - Radio Engineering (3 credits)
Wireless application circuit design for gain and filter control at radio frequencies to interface the baseband processing systems and the antennas of communication systems. 4605: Design of radio transmitter and receiver circuits using scattering-parameter methods. Circuits include oscillators, radio frequency amplifiers and matching networks, mixers and detectors. 4606: Design of amplitude, frequency, and pulse-modulated communication systems, including modulators, detectors, and the effects of noise. Design basics and guidelines for phase-locked loops and several power amplifier configurations.
Prerequisite(s): ECE 4605
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4624 - Digital Signal Processing And Filter Design (3 credits)
Analysis, design, and realization of digital filters. Discrete Fourier Transform algorithms, digital filter design procedures, coefficient quantization. Pre: C or better in 3704
Prerequisite(s): ECE 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4634 - Digital Communications (3 credits)
System and signal level analysis and design for digital communications systems. Review of analog-to-digital conversion and digital baseband communications. Detailed analysis of digital carrier modulation formats including assessment of signal-to-noise ratio, bit error rate, and power and bandwidth efficiency for amplitude-shift keying (ASK), phase-shift keying (PSK), frequency-shift keying (FSK), and Quadrature-Amplitude Modulation (QAM). Matched filter receivers and receiver design, link budgets, and multiple access. Additive-white-noise Gaussian channels. A detailed discussion of random variables will be included to supplement prerequisite material. A C- or better is required in prerequisites.
Prerequisite(s): ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4644 - Satellite Communications (3 credits)
Theory and practice of satellite communications. Orbits and launchers, spacecraft, link budgets, modulation, coding, multiple access techniques, propagation effects, and earth terminals.
Prerequisite(s): ECE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4664 - Analog and Digital Communications Laboratory (1 credit)
Laboratory experiments which deal with the design and measurement of analog and digital communication systems. Concepts include SNR, Modulation Index, PCM, and spread spectrum.
Prerequisite(s): ECE 3614
Corequisite(s): ECE 4634
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4675 - Radio Engineering Laboratory (1 credit)
Laboratory techniques for radio frequencies including the design of amplifiers, oscillators, and a single-side-band receiver. Associated measurements will be used.
Prerequisite(s): ECE 3106 and ECE 3204
Corequisite(s): ECE 4605
Instructional Contact Hours: (3 Lab, 1 Crd)

ECE 4684 - Network Science (3 credits)
Introduction to modern-day networked technologies such as wireless, social, and economic networks. Analysis of networked technologies using analytical and engineering techniques such as optimization, game/auction theory, graph analysis, and learning as applied to networked technologies. Introduction to the basics of these techniques and their applications in networked systems. Development of a network science for solving practical problems pertaining to various networked systems such as smartphones, Wiki, Facebook, recommendation systems, economic network, or online video/music streaming software.
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Crd)

ECE 4704 - Principles of Robotics Systems (3 credits)
Introduction to the design, analysis, control, and operation of robotic mechanisms. Introduction to the use of homogeneous coordinates for kinematics, dynamics, and camera orientation; sensors and actuators, control, task planning, vision, and intelligence. II
Prerequisite(s): ECE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4805 - Senior Design Project (3 credits)
Industry-like two-semester, team-based major design experience applying knowledge and skills acquired in previous coursework. Design and implement solutions to meet multiple realistic constraints; design to incorporate appropriate engineering standards. A specific, complex engineering design problem is taken from problem definition to product realization and testing. Within the design process, topics include written/oral communication, discourse, ethical reasoning, professional development, project management, and working within a team. 4805: Identify, formulate, and define engineering problem. Generate and select design alternatives. Apply design and analysis methods, from previous courses, to develop, evaluate, and communicate detailed project design. 4806: Implement and refine project design from ECE 4805. Test, analyze, document, and deliver the resulting project outcomes. Pre: 2804 (C-), (12 credit hours of C- or better within their declared disciplinary major) or (9 credit hours of C- or better within their declared disciplinary major and 3 credit hours of C- or better within their secondary focus) for 4805; 4805 (C-) for 4806.
Prerequisite(s): ECE 2214 and ECE 2564 and ECE 2714 and ECE 2804 and (ECE 3004 or ECE 3504) and (ECE 3105 or ECE 3514) and (ECE 3106 or ECE 3134 or ECE 3204 or ECE 3214 or ECE 3304 or ECE 3544 or ECE 3564 or ECE 3574 or ECE 3614 or ECE 3704 or ECE 4205 or ECE 4234 or ECE 4254 or ECE 4424 or ECE 4524 or ECE 4540 or ECE 4580 or ECE 4704)
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4806 - Senior Design Project (3 credits)
Industry-like two-semester, team-based major design experience applying knowledge and skills acquired in previous coursework. Design and implement solutions to meet multiple realistic constraints; design to incorporate appropriate engineering standards. A specific, complex engineering design problem is taken from problem definition to product realization and testing. Within the design process, topics include written/oral communication, discourse, ethical reasoning, professional development, project management, and working within a team. 4805: Identify, formulate, and define engineering problem. Generate and select design alternatives. Apply design and analysis methods, from previous courses, to develop, evaluate, and communicate detailed project design. 4806: Implement and refine project design from ECE 4805. Test, analyze, document, and deliver the resulting project outcomes. Pre: 2804 (C-), (12 credit hours of C- or better within their declared disciplinary major) or (9 credit hours of C- or better within their declared disciplinary major and 3 credit hours of C- or better within their secondary focus) for 4805; 4805 (C-) for 4806.
Prerequisite(s): ECE 4805
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECE 4944 - Cybersecurity Seminar (1 credit)
Theory and practice of cybersecurity problems and solutions for building secure computing hardware, software, and networks. Technical, social and legal aspects of secure systems. Historical and ongoing attacks that spawn real-world responses. Ongoing research in cybersecurity defenses. Senior standing.
Prerequisite(s): ECE 2544 or CS 2505
Instructional Contact Hours: (1 Lec, 1 Crd)

ECE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECE 4974 - Independent Study (1-19 credits)
A minimum in-major GPA of 2.0 is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 4984 - Special Study (1-19 credits)
A minimum in-major GPA of 2.5 is required for enrollment.
Instructional Contact Hours: Variable credit course

ECE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ECE 4994 - Undergraduate Research (1-19 credits)
A minimum GPA of 2.0 in all ECE courses is required for enrollment.
Instructional Contact Hours: Variable credit course

Applied Electromagnetics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1

ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3106	Electromagnetic Fields	3
ECE 3104	Introduction to Space Systems and Technologies	3
or ECE 3134	Introduction to Optoelectronics	
or ECE 3604	Introduction to RF and Microwave Engineering	
ECE 3614	Introduction to Communication Systems	3
Subtotal		15
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
EM Electives		6
Math Elective		3
Secondary Focus Area Electives		9
Free Electives		10
Subtotal		28
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A ; C-)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
If Pathways 7 is double counted with another course, these credit hours will be free elective.		3
Subtotal		53
Total Credits		**129**

Secondary Focus Requirement

The ECE secondary focus requirement can be completed in one of two ways:

Focus Areas within ECE

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about

how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.

3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

Electromagentics (EM) Electives

The courses listed below are approved for Applied Electromagnetics elective credit. Students must choose 2 courses to complete the Applied Electromagnetic Major requirements. Actual course offerings will be based on sufficient resources, including faculty availability and student demand. Refer to the University's on-line timetable of classes for specific course availability information. Note: All ECE courses require a C- or better in prerequisite courses. Courses used toward the 6c elective requirement cannot be used as part of the secondary focus.

Code	Title	Credits
ECE 3104	Introduction to Space Systems and Technologies	3
ECE 3134	Introduction to Optoelectronics	3
ECE 3204	Analog Electronics	3
ECE 3604	Introduction to RF and Microwave Engineering	3
ECE 4104	Microwave and RF Engineering	4
ECE 4114	Antennas	3
ECE 4124	Radio Wave Propagation	3
ECE 4134	Photonics	3
ECE 4144	Optical Systems	3
ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
or AOE 4654	Space Weather: The Solar Wind and Magnetosphere	
ECE 4164	Introduction to Global Positioning System (GPS) Theory and Design	4
ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
or AOE 4674	Upper Atmosphere/Ionosphere Space Weather	
ECE 4194	Engineering Principles of Remote Sensing	3
ECE 4205	Electronic Circuit Design	3
ECE 4220	Analog Integrated Circuit Design	3
ECE 4605	Radio Engineering	3
ECE 4644	Satellite Communications	3
ECE 4974	Independent Study	1-19
or ECE 4994	Undergraduate Research	

Math Elective

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Applied Electromagnetics in-major GPA, all ECE courses plus ENGE 4735 and ENGE 4736, including repeats, are used.

Grade Requirement for Core Courses

Students must earn a C or higher in all ECE core courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, and ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in all ECE core courses (listed above). There are no hidden prerequisites in this program of study. Prerequisites may change from

what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + MATH 2214
3. ENGE 4735 + ENGE 4736 may be substituted for ECE 4805 Senior Design Project + ECE 4806. Students who wish to enroll in ENGE 4735 /ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6a		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Math Elective		3
Secondary Focus Area		3
	Credits	**16**
Spring Semester		
ECE 3104 or ECE 3134 or ECE 3604	Introduction to Space Systems and Technologies or Introduction to Optoelectronics or Introduction to RF and Microwave Engineering	3
ECE 3106	Electromagnetic Fields	3
Secondary Focus Area		3
Secondary Focus Area		3
Pathways 2 or 3 or 6a		3
Free Elective		3
	Credits	**18**
Fourth Year		
Fall Semester		
ECE 3614	Introduction to Communication Systems	3
ECE 4805	Senior Design Project (C-)	3
EM Elective		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
EM Elective		3
Pathways 2 or 3 or 6a		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		4
	Credits	**16**
	Total Credits	**129**

Chip-Scale Integration Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3574	Applied Software Design	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3544	Digital Design I (C-)	4
ECE 3004	AC Circuit Analysis	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 4540	VLSI Circuit Design	3
ECE 4514	Digital Design II	4
Subtotal		24
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3

STAT 4714	Probability and Statistics for Electrical Engineers	3
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	Introduction to Proofs	
Subtotal		12
Elective Courses		
Secondary Focus Area Electives		9
Free Elective Credits		7
Subtotal		16
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Arts Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**128**

Secondary Focus

The Chip-Scale Integration Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course

is a prerequisite to one or more of the other two courses in the individualized secondary focus.

d. A minimum of one course must be at the 4xxx level.

4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Chip-Scale Integration in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project . Students who wish to enroll in ENGE 4735 /ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Select three credits from Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Select three credits from Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3514	Data Structures & Algorithms (C-)	3

ECE 3544	Digital Design I (C-)	4
STAT 4714	Probability and Statistics for Electrical Engineers	3
Secondary Focus Area Elective		3
	Credits	**16**
Spring Semester		
ECE 3004	AC Circuit Analysis	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3574	Applied Software Design	3
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Free Elective		3
	Credits	**16**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
ECE 4540	VLSI Circuit Design	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Pathways 2 or 3 or 6A		3
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ECE 4514	Digital Design II	4
ECE 4806	Senior Design Project	3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Pathways 2 or 3 or 6A		3
Free Elective		4
	Credits	**17**
	Total Credits	**128**

Computer Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3574	Applied Software Design (C-)	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3544	Digital Design I	4
Subtotal		13
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics Introduction to Proofs	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		12
Elective Courses		
Secondary Focus Area Electives		9
Technical Electives		9
Free Elective Credits		9
Subtotal		27
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
ENGL 1106	First-Year Writing	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (C-)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable	4
MATH 1226	Calculus of a Single Variable	4
MATH 2214	Introduction to Differential Equations (C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select one 6A		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**128**

Technical Electives

The courses listed below are approved for CpE design technical elective credit. Students must choose 2 courses to complete the Computer Engineering Major requirements. **Actual course offerings will be based on sufficient resources, including faculty availability and student demand.** Refer to the University's on-line timetable of classes for specific course availability information. Note: All ECE courses require a **C- or better** in prerequisite courses. Courses used toward the 9c technical elective requirement cannot be used as part of the secondary focus.

Code	Title	Credits
ECE 3564	Introduction to Computer Networking	3
ECE 4414 or CS 4224	Linux Kernel Programming Linux Kernel Programming	3
ECE 4424/ CS 4824 or ECE 5424	Machine Learning Advanced Machine Learning	3
ECE/CS 4504	Computer Organization	3
ECE 4514	Digital Design II	4

ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4525	Video Game Design and Engineering	3
ECE 4540	VLSI Circuit Design	3
ECE 4550	Real-Time Systems	3
ECE 4554	Introduction to Computer Vision	3
or ECE 5554	Computer Vision	
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4564	Network Application Design	3
ECE 4574	Large-Scale Software Development for Engineering Systems	3
ECE 4580	Digital Image Processing	3
ECE 4704	Principles of Robotics Systems	3
ECE 4974	Independent Study (requires departmental and college approval) [1]	3
or ECE 4994	Undergraduate Research	

[1] No more than 3 hours total of either ECE 4974 Independent Study or ECE 4994 Undergraduate Research can be counted toward the Computer Engineering Major

Secondary Focus

The Computer Engineering Major requires 9 credits from a single focus area. All 9 credits must be from one ECE focus area from the attached list. At least 3 credits must be at the 4xxx level.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)

- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (In determining the BSCPE and BSEE in-major GPA, all ECE courses, including repeats, are used).

Graduation Requirements

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Computer Engineering in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change form what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H may be substituted for MATH 2114
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 + MATH 2204 + MATH 2214
3. ENGE 4735 + ENGE 4736 may be substituted for ECE 4805 + ECE 4806. Students who wish to enroll in ENGE 4735/4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.
4. Substituting required courses with graduate-level courses. Students in their senior year, with a 3.0 or better GPA, may enroll in 5000-level courses to satisfy undergraduate degree requirements within their department with the permission of the course instructor and the Department Head. Should the student become a graduate student, these courses may not be used on the Plan of Study for a graduate degree.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6a		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Pathways 2 or 3 or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture	3
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3544	Digital Design I	4
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Secondary Focus Area Elective		3
	Credits	**16**
Spring Semester		
ECE 3574	Applied Software Design (C-)	3
Technical Elective		3
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6a		3
Free Elective		3
	Credits	**18**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Technical Elective		3
Pathways 2 or 3 or 6a		3
Pathways 2 or 3 or 6a		3
	Credits	**15**

Spring Semester		
ECE 4806	Senior Design Project	3
Technical Elective		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
Free Elective		3
	Credits	**15**
	Total Credits	**128**

Controls, Robotics & Autonomy Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3704	Continuous and Discrete System Theory (C-)	3
ECE 3514	Data Structures & Algorithms	3
ECE 3714	Introduction to Control Systems	3
Control, Robotics, & Autonomy Electives		
Select two of the following:		6
ECE 4704	Principles of Robotics Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
Subtotal		21
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
Secondary Focus Area Electives		9
Math Elective		3
Free Electives		10
Subtotal		22
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**129**

Math Elective Requirement

Controls, Robotics & Autonomy majors are required to take one math elective course from the following list. Some courses may include prerequisite courses not required for the EE curriculum. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Note that courses may be restricted to specific majors during certain semesters.

Enrollment into courses will be based on sufficient resources, including faculty availability and student demand.

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Secondary Focus

The Controls, Robotics & Autonomy (EE) Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Controls, Robotics & Autonomy in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed after the course title. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no

hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project. Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3105	Electromagnetic Fields (C-)	3
ECE 3704	Continuous and Discrete System Theory (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Secondary Focus Area Elective		3
	Credits	**16**
Spring Semester		
ECE 3514	Data Structures & Algorithms	3
ECE 3714	Introduction to Control Systems	3
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**18**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
Select one of the following:		3
ECE 4704	Principles of Robotics Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
Math Elective from list		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
Select one of the following:		3
ECE 4704	Principles of Robotics Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
Pathways 2 or 3 or 6A		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		4
	Credits	**16**
	Total Credits	**129**

Controls, Robotics & Autonomy Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms	3
ECE 3574	Applied Software Design	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture	3

ECE 3704	Continuous and Discrete System Theory	3
Select three of the following:		9
ECE 3714	Introduction to Control Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
ECE 4704	Principles of Robotics Systems	
Subtotal		21
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	Introduction to Proofs	
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Elective Courses		
Secondary Focus Area Electives		9
Free Elective		10
Subtotal		31
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Arts Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**128**

Secondary Focus

The Controls, Robotics & Autonomy (CPE) Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about

how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.

3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Controls, Robotics & Autonomy (CPE) in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed . In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project . Students who wish to enroll in ENGE 4735 /ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Select three credits in Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**

Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3514	Data Structures & Algorithms (C-)	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Secondary Focus Elective		3
	Credits	**15**
Spring Semester		
ECE 3574	Applied Software Design	3
ECE 3704	Continuous and Discrete System Theory	3
Secondary Focus Elective		3
Secondary Focus Elective		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**18**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
Select one of the following:		3
ECE 3714	Introduction to Control Systems	
ECE 4704	Principles of Robotics Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
Pathways 2 or 3 or 6A		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
Select two of the following:		6
ECE 3714	Introduction to Control Systems	
ECE 4704	Principles of Robotics Systems	
ECE 4524	Artificial Intelligence and Engineering Applications	
ECE 4580	Digital Image Processing	
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		4
	Credits	**16**
	Total Credits	**128**

Electrical Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3106	Electromagnetic Fields	3
ECE 3204	Analog Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3304	Introduction to Power Systems	3
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3614	Introduction to Communication Systems	3
ECE 3704	Continuous and Discrete System Theory	3
Subtotal		23
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
Math Elective		3
Secondary Focus Area Electives		9
Free Electives		8
Subtotal		20
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D ;)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		

Pathways 7 should be double counted with either Pathways 2, 3, or 6a to avoid taking any additional credit hours.	3
Subtotal	53
Total Credits	**129**

Secondary Focus Requirement

The ECE secondary focus requirement can be completed in one of two ways:

Focus Areas within ECE

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

MATH Elective Requirement

Electrical Engineering majors are required to take one math elective course from the following list. Some courses may include prerequisite courses not required for the BSEE curriculum. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Note that courses may be restricted to specific majors during certain semesters.

Enrollment into courses will be based on sufficient resources, including faculty availability and student demand.

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)

- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Electrical Engineering in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project. Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ENGE 1215	Foundations of Engineering	2
ECE 1004	Introduction to ECE Concepts (C)	3
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6a		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
ECE 3704	Continuous and Discrete System Theory	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Pathways 2 or 3 or 6a		3
	Credits	**16**
Spring Semester		
ECE 3106	Electromagnetic Fields	3
ECE 3204	Analog Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3304	Introduction to Power Systems	3
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3614	Introduction to Communication Systems	3
Pathways 2 or 3 or 6a		3
	Credits	**17**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
Secondary Focus Area course (see list)		3
Secondary Focus Area course (see list)		3
MATH Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
Secondary Focus Area course (see list)		3

Pathways 2 or 3 or 6a		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
Free Elective		2
	Credits	**17**
	Total Credits	**129**

Energy & Power Electronic Systems Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3204	Analog Electronics (C-)	3
ECE 3304	Introduction to Power Systems (C-)	3
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3704	Continuous and Discrete System Theory	3
ECE 4224	Power Electronics	3
ECE 4334	Power System Analysis and Control	3
Subtotal		22
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
Math Elective		3
Secondary Focus Area Electives		9
Free Electives		9
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A ; C-)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**129**

Secondary Focus

The Energy & Power Electronics Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Electives

The ERES major requires 3 hours Math electives from list and 8 hours of free electives. Only free electives may be taken under the P/F grading option. Students are encouraged to use free electives to provide depth in major or secondary focus.

Secondary Focus Requirement

Focus Areas Within ECE

The courses listed below are grouped into suggested ECE focus areas. Students are encouraged to choose 3 courses from a single focus area that is not their chosen major. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirement as long as at least one course (3 credits) is at the 4xxx level. **None of the 3 courses can duplicate a course from the student's major. Actual course offerings will be based on sufficient resources, including faculty availability and student demand.** Refer to the University's on-line timetable of classes for specific course availability information and prerequisite. Note: All ECE courses require a **C- or better** in prerequisite courses unless a C or better is noted on the checksheet.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used

for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

MATH Elective Requirement

Energy and Power Electronics Systems majors are required to take one math elective course from the following list. Some courses may include prerequisite courses not required for the EE curriculum. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Note that courses may be restricted to specific majors during certain semesters.

Enrollment into courses will be based on sufficient resources, including faculty availability and student demand.

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 132 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Energy & Power Electronics Systems in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed after the course title. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project. Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3105	Electromagnetic Fields (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6a		3
	Credits	**16**
Spring Semester		
ECE 3204	Analog Electronics (C-)	3
ECE 3304	Introduction to Power Systems (C-)	3
ECE 3354	Electric Power Engineering Laboratory	1
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Free Elective		3
	Credits	**16**
Fourth Year		
Fall Semester		
ECE 3704	Continuous and Discrete System Theory	3
ECE 4224	Power Electronics	3
ECE 4334	Power System Analysis and Control	3
ECE 4805	Senior Design Project (C-)	3
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
MATH Elective		3
Pathways 2 or 3 or 6a		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
Free Elective		3
	Credits	**18**
	Total Credits	**129**

Machine Learning Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3

ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3574	Applied Software Design (C-)	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 4424/ CS 4824	Machine Learning	3
or ECE 5424	Advanced Machine Learning	
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4525	Video Game Design and Engineering	3
or ECE 4580	Digital Image Processing	
ECE 4554	Introduction to Computer Vision	3
or ECE 5554	Computer Vision	
Subtotal		22
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	Introduction to Proofs	
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Subtotal		12
Elective Courses		
Secondary Focus Area Electives		9
Free Electives		9
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Arts Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours		3
Subtotal		53
Total Credits		**128**

Secondary Focus

The Machine Learning Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Machine Learning in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed after the course title. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project . Students who wish to enroll in ENGE 4735 /ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.
4. Substituting required courses with graduate-level courses. Students in their senior year, with a 3.0 or better GPA, may enroll in 5000-level courses to satisfy undergraduate degree requirements within their department with the permission of the course instructor and the Department Head. Should the student become a graduate student, these courses may not be used on the Plan of Study for a graduate degree.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language.

College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3514	Data Structures & Algorithms (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Secondary Focus Area Elective		3
Free Elective		3
Free Elective		3
	Credits	**18**
Spring Semester		
ECE 3574	Applied Software Design (C-)	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Elective		3
Pathways 2 or 3 or 6A		3
	Credits	**16**
Fourth Year		
Fall Semester		
ECE 4805	Senior Design Project (C-)	3
ECE 4424	Machine Learning	3
ECE 4525 or ECE 4580	Video Game Design and Engineering or Digital Image Processing	3
ECE 4554	Introduction to Computer Vision	3
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6A		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
	Credits	**15**
	Total Credits	**128**

Micro/Nanosystems Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3214	Semiconductor Device Fundamentals	3
ECE 3204	Analog Electronics (C-)	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3614	Introduction to Communication Systems (C-)	3
Select two of the following:		6
ECE 4205	Electronic Circuit Design	
ECE 4220	Analog Integrated Circuit Design	
ECE 4234	Semiconductor Processing	
ECE 4254	Principles of Electronics Packaging	
Subtotal		22
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
Math Elective		3
Secondary Focus Area Electives		9
Free Electives		9
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6

Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D ; C-)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**129**

Electives

The Micro/Nanosystems major requires 3 hours of math electives from list and 9 hours of free electives. Only free electives may be taken under the P/F grading option. Students are encouraged to use free electives to provide depth in their major or secondary focus.

Secondary Focus

The Micro/Nanosystems Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.

6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

MATH Elective Requirement

Micro-Nanosystems majors are required to take one math elective course from the following list. Some courses may include prerequisite courses not required for the EE curriculum. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Note that courses may be restricted to specific majors during certain semesters

Enrollment into courses will be based on sufficient resources, including faculty availability and student demand.

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats.

Graduation Requirements

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed after the course title. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Micro/Nanosystems in-major GPA, all ECE courses, including repeats, are used.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project. Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGL 1106	First-Year Writing	3
ENGE 1216	Foundations of Engineering	2
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3

PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
ECE 3214	Semiconductor Device Fundamentals	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Secondary Focus Area Elective		3
	Credits	**16**
Spring Semester		
ECE 3204	Analog Electronics (C-)	3
ECE 3274	Electronic Circuits Laboratory II	1
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6A		3
Pathways 2 or 3 or 6A		3
	Credits	**16**
Fourth Year		
Fall Semester		
ECE 3614	Introduction to Communication Systems	3
ECE 4805	Senior Design Project (C-)	3
Select one of the following:		3
ECE 4205	Electronic Circuit Design	
ECE 4220	Analog Integrated Circuit Design	
ECE 4234	Semiconductor Processing	
ECE 4254	Principles of Electronics Packaging	
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 4806	Senior Design Project	3
Select one of the following:		3
ECE 4205	Electronic Circuit Design	
ECE 4220	Analog Integrated Circuit Design	
ECE 4234	Semiconductor Processing	
ECE 4254	Principles of Electronics Packaging	
MATH Elective		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
Free Elective		3
	Credits	**18**
	Total Credits	**129**

Networking & Cybersecurity Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3574	Applied Software Design (C-)	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3564	Introduction to Computer Networking (C-)	3
CS 4264	Principles of Computer Security	3
ECE 4564	Network Application Design	3
ECE 4560	Computer and Network Security Fundamentals	3
Subtotal		21
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics Introduction to Proofs	3
Subtotal		12
Elective Courses		
Secondary Focus Area Electives		9
Free Elective Credits		10
Subtotal		19
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Arts Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D) Foundations of Engineering Practice	4

Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.	3
Subtotal	53
Total Credits	**128**

Secondary Focus

The Controls, Robotics & Autonomy (CPE) Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Course ECE 4974 Not Found and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus
(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Networking & Cybersecurity in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project . Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGL 1106	First-Year Writing	3
ENGE 1216	Foundations of Engineering	2
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3514	Data Structures & Algorithms (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Secondary Focus Area Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
ECE 3564	Introduction to Computer Networking (C-)	3
ECE 3574	Applied Software Design (C-)	3
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**18**
Fourth Year		
Fall Semester		
ECE 4564	Network Application Design	3
ECE 4805	Senior Design Project (C-)	3
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Pathways 2 or 3 or 6A		3
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ECE 4560	Computer and Network Security Fundamentals	3
ECE 4806	Senior Design Project	3
CS 4264	Principles of Computer Security	3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		4
	Credits	**16**
	Total Credits	**128**

Software Systems Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3

ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3514	Data Structures & Algorithms (C-)	3
ECE 3574	Applied Software Design (C-)	3
Subtotal		23
Major Requirements		
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
ECE 4525	Video Game Design and Engineering	3
or ECE 4574	Large-Scale Software Development for Engineering Systems	
CS 3214	Computer Systems	3
ECE 4550	Real-Time Systems	3
Subtotal		22
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
MATH 2534	Introduction to Discrete Mathematics	3
or MATH 3034	Introduction to Proofs	
Subtotal		12
Elective Courses		
Secondary Focus Area Electives		9
Free Electives		9
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Arts Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		53
Total Credits		**128**

Secondary Focus

The Software Systems Major requires 9 credits for a secondary focus area. Students have the flexibility to choose any 3 ECE courses (9 credits) at the 3xxx level or 4xxx level to meet the secondary focus requirements as long as at least one course (3 credits) is at the 4xxx level and the courses do not duplicate major courses. Alternatively, students may seek an approved individualized secondary focus. See the requirements below (page 3) for more information.

Secondary Focus Requirement

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654/ ECE 4154	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674/ ECE 4174	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224/ ECE 4414	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS/ECE 4504	Computer Organization	3
CS 4824/ ECE 4424	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

1.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Software Systems in-major GPA, all ECE courses, including repeats, are used.

Grade Requirement

Students must earn a C or higher in the following ECE courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in the ECE courses listed above. There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project . Students who wish to enroll in ENGE 4735 /ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3

MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus	3
Pathways 2 or 3 or 6A		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3504	Principles of Computer Architecture (C-)	3
ECE 3514	Data Structures & Algorithms (C-)	3
STAT 4714	Probability and Statistics for Electrical Engineers (C-)	3
Secondary Focus Area Elective		3
Free Elective		3
Free Elective		3
	Credits	**18**
Spring Semester		
ECE 3574	Applied Software Design (C-)	3
ECE 4524	Artificial Intelligence and Engineering Applications	4
MATH 2534 or MATH 3034	Introduction to Discrete Mathematics or Introduction to Proofs	3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6A		3
	Credits	**16**
Fourth Year		
Fall Semester		
ECE 4525 or ECE 4574	Video Game Design and Engineering or Large-Scale Software Development for Engineering Systems	3
ECE 4805	Senior Design Project (C-)	3
CS 3214	Computer Systems	3
Pathways 2 or 3 or 6A		3
Pathways 2 or 3 or 6A		3
	Credits	**15**
Spring Semester		
ECE 4550	Real-Time Systems	3
ECE 4806	Senior Design Project	3
Secondary Focus Area Elective		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
	Credits	**15**
	Total Credits	**128**

Wireless Communications and Signal Processing Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ECE 1004	Introduction to ECE Concepts (C)	3
ECE 2024	Circuits and Devices (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
ECE 2214	Physical Electronics (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
Subtotal		24
Major Requirements		
ECE 2514	Computational Engineering (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 3564	Introduction to Computer Networking	3
ECE 3614	Introduction to Communication Systems	3
ECE 3704	Continuous and Discrete System Theory	3
ECE 4624	Digital Signal Processing And Filter Design	3
ECE 4634	Digital Communications	3
ECE 4664	Analog and Digital Communications Laboratory	1
Subtotal		22
Additional Course Requirements		
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Subtotal		9
Elective Courses		
Math Elective		3
Secondary Focus Area Electives		9
Free Electives		9
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ECE 4805 & ECE 4806	Senior Design Project and Senior Design Project (1A ; C-)	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		

MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
If Pathways 7 is double counted with another course, these credit hours will be free elective.		3
Subtotal		53
Total Credits		**129**

Secondary Focus Requirement

The ECE secondary focus requirement can be completed in one of two ways:

Focus Areas within ECE

The ECE secondary focus requirement consists of 3 ECE courses (9 credits) at the 3xxx level, 4xxx level, or 5xxx level where at least one course (3 credits) is at the 4xxx or 5xxx level. **None of the 3 courses can duplicate a course from the student's major.** All courses used for secondary focus must be taken on an A-F basis. For purposes of satisfying the secondary focus requirements, the sum of the number of hours taken from ECE 4974 Independent Study and ECE 4994 Undergraduate Research cannot exceed 6 credits.

The following courses are also included in the secondary focus:

Code	Title	Credits
AOE 4654	Space Weather: The Solar Wind and Magnetosphere	3
AOE 4674	Upper Atmosphere/Ionosphere Space Weather	3
CS 3214	Computer Systems	3
CS 4224	Linux Kernel Programming	3
CS 4264	Principles of Computer Security	3
CS 4504	Computer Organization	3
CS 4824	Machine Learning	3

The following courses **cannot** be used toward secondary focus:

Code	Title	Credits
ECE 3054	Electrical Theory	3
ECE 3074	AC Circuit Analysis Laboratory	1
ECE 3254	Industrial Electronics	3
ECE 3274	Electronic Circuits Laboratory II	1
ECE 3354	Electric Power Engineering Laboratory	1
ECE 3524	Introduction to Unix for ECE	2
ECE 4944	Cybersecurity Seminar	1

Individualized Secondary Focus

(Must be preapproved by ECE Department)

Electrical and computer engineering has applications across a wide variety of fields, such as medicine, human-computer interaction, finance, and entertainment. People with ECE degrees can be entrepreneurs, patent lawyers, policy makers, and business executives. The individualized secondary focus helps students pursue these interests. This option can be used in place of a pre-defined, in-department secondary focus.

The individualized secondary focus typically is pursued via an already defined university-approved program such as a degree, major, minor, or certificate that the student has declared. Students are encouraged to select courses from these programs, subject to the guidelines below.

1. To begin this process, students must first meet with their academic advisor.
2. The student must complete a brief proposal form describing the expected added value to their major. This includes a narrative about how these courses support the student's career goals and ability to achieve their professional aspirations. This proposal must be approved by the Director of Undergrad Program or designee.
3. Individualized secondary focus plans must include 3 courses within the following parameters:
   a. None of the courses may duplicate the student's ECE major requirements.
   b. None of the courses can be at the 1xxx level (1xxx courses required for university-approved programs, e.g. minors, can be used for a student's free electives).
   c. A maximum of one course can be at the 2xxx level, and only if it is a requirement of a university approved program, or if the course is a prerequisite to one or more of the other two courses in the individualized secondary focus.
   d. A minimum of one course must be at the 4xxx level.
4. If the set of courses is part of an already defined university program, the student should attach documentation to the proposal form.
5. If the set of three courses are not part of an already defined university-approved program, the student must also obtain written approval from the department that houses the courses.
6. It is the student's responsibility to ensure that the set of courses is available to be taken in a timely manner. The ECE department is not responsible for changes of programs elsewhere in the university.

Math Elective

Code	Title	Credits
MATH 2534	Introduction to Discrete Mathematics	3
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH/CS 3414	Numerical Methods	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ECE Department fully supports this policy. Specific expectations for satisfactory progress for BSCPE and BSEE majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (under Academic Policies)
- Upon completing 2 semesters in ECE, students must have satisfactorily completed ECE 2024 Circuits and Devices, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, MATH 2214 Introduction to Differential Equations, and PHYS 2306 Foundations of Physics
- Upon completing 3 semesters in ECE, students must have satisfactorily completed ECE 2804 Integrated Design Project.
- Upon attempting 90 credits, BSCPE and BSEE students must have successfully completed 33 credits of in-major courses and have 2.0 overall and in-major GPAs. (The BSCPE and BSEE in-major GPA includes all ECE courses, including repeats).

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In determining the Applied Electromagnetics in-major GPA, all ECE courses plus ENGE 4735 and ENGE 4736, including repeats, are used.

Grade Requirement for Core Courses

Students must earn a C or higher in all ECE core courses: ECE 1004 Introduction to ECE Concepts, ECE 2024 Circuits and Devices, ECE 2214 Physical Electronics, ECE 2514 Computational Engineering, ECE 2544 Fundamentals of Digital Systems, ECE 2564 Embedded Systems, ECE 2714 Signals and Systems, and ECE 2804 Integrated Design Project.

Statement of Prerequisites

Pre-requisites for each course are listed. In general, all ECE courses require a C- or better in prerequisite courses. Students must earn a C or higher in all ECE core courses (listed above). There are no hidden prerequisites in this program of study. Prerequisites may change from what is indicated. Be sure to consult the Timetable of Classes or check with your advisor for the most current requirements.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context + MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra + MATH 2204 Introduction to Multivariable Calculus + MATH 2214 Introduction to Differential Equations
3. ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for ECE 4805 Senior Design Project + ECE 4806 Senior Design Project. Students who wish to enroll in ENGE 4735/ENGE 4736 must successfully complete all prerequisites for ECE 4805 and must be approved by the Director of the ECE Major Design Experience prior to enrolling. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
ECE 1004	Introduction to ECE Concepts (C)	3
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways 2 or 3 or 6a		3
	Credits	**15**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra (C-)	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
ECE 2024	Circuits and Devices (C)	3
ECE 2514	Computational Engineering (C)	3
ECE 2544	Fundamentals of Digital Systems (C)	3
MATH 2214	Introduction to Differential Equations (C-)	3
PHYS 2306	Foundations of Physics (C-)	4
	Credits	**16**
Spring Semester		
ECE 2214	Physical Electronics (C)	3
ECE 2564	Embedded Systems (C)	3
ECE 2714	Signals and Systems (C)	3
ECE 2804	Integrated Design Project (C)	2
MATH 2204	Introduction to Multivariable Calculus (C-)	3
Pathways 2 or 3 or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECE 3004	AC Circuit Analysis (C-)	3
ECE 3074	AC Circuit Analysis Laboratory (C-)	1
ECE 3105	Electromagnetic Fields (C-)	3
ECE 3704	Continuous and Discrete System Theory	3
STAT 4714	Probability and Statistics for Electrical Engineers	3
Secondary Focus Area Elective		3
	Credits	**16**
Spring Semester		
ECE 3564	Introduction to Computer Networking	3
ECE 3614	Introduction to Communication Systems	3
Secondary Focus Area Elective		3
Secondary Focus Area Elective		3
Pathways 2 or 3 or 6a		3
	Credits	**15**
Fourth Year		
Fall Semester		
ECE 4624	Digital Signal Processing And Filter Design	3
ECE 4634	Digital Communications	3
ECE 4664	Analog and Digital Communications Laboratory	1
ECE 4805	Senior Design Project (C-)	3
Pathways 2 or 3 or 6A		3
Free Elective		3
	Credits	**16**

Spring Semester		
ECE 4806	Senior Design Project	3
Math Elective		3
Pathways 2 or 3 or 6a		3
Pathways 7 or Free Elective (if Pathways 7 double counted)		3
Free Elective		3
Free Elective		3
	Credits	**18**
	Total Credits	**129**

Engineering Education

Our Website (http://www.enge.vt.edu)

Overview

The Department of Engineering Education (ENGE) is home to General Engineering (GE) students. The department teaches the interdisciplinary first-year engineering courses, advises General Engineering (GE) students, and offers a graduate certificate and a Ph.D. in engineering education.

At the undergraduate level, the department provides the foundation for students to begin their engineering journey, preparing them for academic success in one of the degree-granting College of Engineering programs and for success as an engineer. At the graduate level, the department prepares scholars to advance knowledge and address significant challenges facing engineering education in careers including engineering faculty, policy makers, corporate training, university assessment and university administration.

Accreditation statements may be found in the listings for individual undergraduate degree programs.

First Year Students and General Engineering

The General Engineering (GE) program of the EngE department serves first-year students in the College of Engineering. Through EngE courses, first-year students participate in problem solving, engineering analysis and design exercises that represent the essence of the engineering profession. The courses emphasize team-based, design-oriented, hands-on experiences to develop students' concepts of engineering and engineering methods, while reinforcing the role of concurrent required courses (e.g. mathematics, English, physics). They also serve as a foundation for subsequent courses in the various engineering curricula. Coverage of engineering ethics instills a sense of the responsibilities of engineers to society. Algorithm development and computer programming develop logical thinking, provide the background for computer use in later courses, and support problem-solving skills. Spatial visualization skills are developed through engineering graphics, a primary engineering tool. Through writing and presentations, students begin to hone their professional communication skills, including audience analysis, visual rhetoric, effective writing styles, issues in collaborative writing, techniques of oral presentation, print and Web-based research, graphics for written and oral presentations, and editing.

General Engineering students have access to the **Frith First-Year Makerspace** run by the Engineering Education department. The Frith First-Year Makerspace (formerly the Frith Lab) is designed to support the retention and development of young engineers through hands-on learning, peer mentoring, and authentic problem-solving. Part collaboration and innovation space, part fabrication and prototyping space, and part learning laboratory, Frith is integrated into the first-year foundations of engineering courses and enables General Engineering students to learn by dissecting, designing, making, and analyzing engineering products. The Makerspace houses equipment for 3D printing, laser cutting, metalworking, woodshop work, and crafts. https://enge.vt.edu/undergraduate/frith.html

All College of Engineering students must own

1. a laptop or 2-in-1 tablet running Windows 10 or 11 and meeting current specifications, and
2. stipulated software used to analyze and solve problems in and out of class.

Computer requirements for engineering students can be located at https://eng.vt.edu/admissions/computer-requirement.html.

Process for Declaring a Degree-Granting Engineering Major

The General Engineering program introduces first-year engineering students to foundational concepts and practices in engineering, allows time to adjust to the College, and provides opportunities to investigate the College's individual degree programs and select the branch of engineering or computer science best suited to their skills and interests. At the end of the year - after academic advising, contacts with the various departments, and satisfactory progress - students select a degree program and, if academically eligible, are transferred to the appropriate degree-granting department.

Entry into a degree-granting engineering department requires that students successfully complete all required first-year courses.

Please see the College of Engineering catalog section titled "Required Academic Progress" for details, and visit https://eng.vt.edu/academics/undergraduate-students/resources-support/change-of-major.html for application policies and dates.

Code	Title	Credits
Typical First Semester		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable	4
Typical Second Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics	4

Head: J.M. Case
Assistant Head for Undergraduate Programs: N.P. Pitterson
Assistant Head for Graduate Programs: W.C. Lee
Professors: J.M. Case, D.B. Knight, V.K. Lohani, H.M. Matusovich, L.D. McNair, and M.C. Paretti
Associate Professors: D. Bairaktarova, J.R. Grohs, T.W. Knott, W.C. Lee, N.P. Pitterson, S.L. Rodriguez, and Q. Zhu
Assistant Professors: M.V. Huerta, A.S. Katz, D. Kim, and S. Sajadi
Associate Professor of Practice: M.B. James, and N.C.T. Van Tyne
Assistant Professor of Practice: N.J. Bedard

Collegiate Assistant Professor: B.D. Chambers, T.Clarke Douglas, D.A. Gray, J.D. Ortega Álvarez, M.M. Soledad, and C. Wallwey
Senior Instructor: J.L. Lo
Instructor: E.H. Dogan and C.A. Twyman
Professor Emeritus: O.H.Griffin
Associate Professor Emeritus: J.B. Connor, R.M. Goff, M.H. Gregg and T.D.L. Walker
Academic and Career Advisors: M. Cheatham, J. Chin, J. Elmore, D. Erb, M. Greene-Havas, A. Mullins, D. Newcomb, J. Newcomer, and A. Noble

E-mail: enge@vt.edu

Undergraduate Course Descriptions (ENGE)

ENGE 1004 - Explore Engineering (1 credit)
Students will participate in a seminar-style experience guided by representatives from different engineering disciplines to learn more about the programs offered by the College of Engineering at Virginia Tech to aid the change of major process.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1014 - Engineering Success Seminar (1 credit)
Introduction to opportunities and resources available to College of Engineering students during their undergraduate career at VT. Practice in information gathering skills critical for engineering students. Practice in oral, written, and visual communication. Preparation of an academic plan.
Corequisite(s): ENGE 1215
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1215 - Foundations of Engineering (2 credits)
A first-year sequence to introduce general engineering students to the profession. 1215 (2 credit) data collection and analysis, engineering problem-solving, mathematical modeling, contemporary software tools, professional practices and expectations (e.g. effective communication, working in teams, ethics), and the diversity of fields and majors within engineering. 1216 (2 credits): data collection and analysis, engineering problem-solving, mathematical modeling, design, contemporary software tools, professional practices and expectations (e.g. communication, teamwork, ethics). 1215: Design Lab/Studio (3L, 2C), 1216: Design Lab/Studio (3L, 2C).
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 2 Crd)

ENGE 1216 - Foundations of Engineering (2 credits)
A first-year sequence to introduce general engineering students to the profession. 1215 (2 credit) data collection and analysis, engineering problem-solving, mathematical modeling, contemporary software tools, professional practices and expectations (e.g. effective communication, working in teams, ethics), and the diversity of fields and majors within engineering. 1216 (2 credits): data collection and analysis, engineering problem-solving, mathematical modeling, design, contemporary software tools, professional practices and expectations (e.g. communication, teamwork, ethics). 1215: Design Lab/Studio (3L, 2C), 1216: Design Lab/Studio (3L, 2C).
Prerequisite(s): ENGE 1215
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 2 Crd)

ENGE 1354 - Introduction to Spatial Visualization (1 credit)
Introduction to spatial visualization. Training to improve three-dimensional visualization skills, pictorial sketching, orthographic projection, mental rotation, mental cutting and folding, combining solids.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 1414 - Foundations of Engineering Practice (4 credits)
Introduction to engineering profession for transfer General Engineering students including engineering problem solving and design, contemporary software tools, and professional practices and expectations (e.g., communication, teamwork, ethics). Duplicates 1215-1216. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (6 Lab, 4 Crd)

ENGE 1644 - Global STEM Practice: Leadership and Culture (3 credits)
Develop global competencies in science, technology, engineering, and math (STEM) contexts and understand how problems and viable solutions vary across contexts and how intercultural communication and global leadership are important in an interconnected global workforce. Integrates semester-long on-campus module with international module following semester exams (Rising Sophomore Abroad Program). International module engages students in local culture during visits with STEM businesses and universities. Participation in both modules required. Enrollment by application.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ENGE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2094 - Create!: Ideation & Innovation (3 credits)
Apply problem solving framing strategies as part of problem solving design processes. Consider cultural, economic, social, and other perspectives in customer discovery and design processes in order to ensure problem/solution fit. Ideate possible solutions or approaches to address open- ended problems using a variety of methods. Engage in iterative critiques of strategies, solutions and prototypes using methods drawn from industrial design, engineering and the arts. Collaborate in interdisciplinary and diverse project teams. Communicate deliverables in multiple formats and for different audiences. Identify and address impacts of designed services and products through global perspectives, such as patterns of inclusion and exclusion and effects on localized ecosystems.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2524 - Exploring Service Learning Through STEAM/STEM Educational Outreach (3 credits)
Explore volunteerism, traditional service learning, critical service learning, and social change. Develop intercultural competence by examining social identities, power, and privilege with a focus on preK-12 education systems in the United States. Develop Science, Technology, Engineering, Arts, and Math (STEAM) and STEM educational outreach experiences that meet needs identified by community members in teams. Demonstrate career readiness through experiential learning. Pre: Sophomore standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2524H - Service Learning Edu. Outreach (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 2634 - Introduction to Restricted Research (1 credit)
Introduction to multi-disciplinary, team-based undergraduate engineering research. Emphasis on Department of Defense (DoD) and Intelligence Community missions and projects. Exposure to current restricted research performed around campus. Guest speakers from national labs. Engineering research methods (tools, research integrity/safety/ethics, and communication of results). Deep dive into International Traffic in Arms Regulations-restricted multi-disciplinary DoD engineering problems, potential careers, and security protocols surrounding restricted research and careers.
Instructional Contact Hours: (1 Lec, 1 Crd)

ENGE 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 2984 - Special Study (1-19 credits)
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Instructional Contact Hours: Variable credit course

ENGE 2984G - Special Study (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

ENGE 2984M - Special Study (1-19 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: Variable credit course

ENGE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 3604 - Introductory Industry Design Experience (3 credits)
Workplace and industry culture and practice, including folkways, mores, and ethics, centered on engineering design. Interaction with industry professionals. Workplace competencies including effective teamwork, project management, presenting technical information. Training with software, tools and skills used in design practice in industry.
Prerequisite(s): ENGE 1215 and ENGE 1216
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ENGE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4094 - Startup: Commercialization of Innovation (3 credits)
Work in interdisciplinary teams in an experiential environment replicating modern innovation environments. Engage in real world innovation commercialization opportunities. Individual experiences and projects involving actual inventions, innovations, technologies, intellectual property (e.g. patents) and market opportunities. Integrate design thinking, scientists, entrepreneurs, advisors and other potential collaborators. Create a representation of a plan for a minimum viable product for an innovative product or service based on customer and market feedback.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IDS 4094, MGT 4094

ENGE 4104 - Applied Explorations in Innovation (3 credits)
Work in interdisciplinary teams to scope and plan an open-ended design project focused on technology commercialization that addresses a need or problem. Model systems and products computationally and quantitatively to address issues of technical and market feasibility and to predict performance under uncertain conditions. Engage in iterative design process that combines computational and quantitative processes with user-centered design and market analysis. Produce viable design that includes technical specifications, market evaluation, and customer discovery results. Communicate with wide range of audiences. Analyze ethical and intercultural and global impacts of innovation. Pre: 3 credits of foundational quantitative and computational thinking.
Prerequisite(s): STS 2254 and ENGE 2094 and (MGT 4094 or ENGE 4094 or IDS 4094)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 6D Critique & Prac in Design, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 4735 - Interdisciplinary Design Capstone (3 credits)
Team-oriented, open-ended, interdisciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product implementation and validation. 4735: Focus on problem identification, development of customer needs, project management, solution validation and selection, solution design, engineering teamwork, documentation and communication. 4736: Focus on design implementation, design validation, ethical and societal impacts of engineering design, communication and teamwork. Students majoring in Material Science and Engineering, Mechanical Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Biomedical Engineering must meet prerequisite and corequisite requirements for their respective in-major capstone courses.
Prerequisite(s): (ME 3024 and ME 3034 and ME 3304 and ME 3524 and ME 3534 and ME 3624 and ME 4005 and MSE 2034) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 4554) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 3304) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4414 and MSE 3204) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4554 and MSE 3304) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 4554 and MSE 3204) or (MSE 4644 and MSE 3044 and MSE 3054 and MSE 3884 and MSE 3304 and MSE 3204) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3106) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3106) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3134) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3134) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3204) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3204) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3214) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3214) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3304) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3304) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3544) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3544) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3564) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3564) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3574) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3574) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3614) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3614) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 3704) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 3704) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4205) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4205) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4234) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4234) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4354) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4354) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4424) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4424) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4524) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4524) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4540) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4540) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4580) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4580) or (ECE 2804 and ECE 3004 and ECE 3105 and ECE 4704) or (ECE 2804 and ECE 3004 and ECE 3514 and ECE 4704) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3106) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3106) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3134) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3134) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3204) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3204) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3214) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3214) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3304) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3304) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3544) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3544) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3564) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3564) or (ECE 2804 and ECE 3504 and ECE 3105 and ECE 3574) or (ECE 2804 and ECE 3504 and ECE 3514 and ECE 3574) or (ECE 2804 and ECE 3504 and ECE 3105

ENGE 4736 - Interdisciplinary Design Capstone (3 credits)
Team-oriented, open-ended, interdisciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product implementation and validation. 4735: Focus on problem identification, development of customer needs, project management, solution validation and selection, solution design, engineering teamwork, documentation and communication. 4736: Focus on design implementation, design validation, ethical and societal impacts of engineering design, communication and teamwork. Students majoring in Material Science and Engineering, Mechanical Engineering, Electrical and Computer Engineering, Industrial and Systems Engineering, and Biomedical Engineering must meet prerequisite and corequisite requirements for their respective in-major capstone courses.
Prerequisite(s): ENGE 4735
Corequisite(s): (MSE 4055 for MSE majors) or (ISE 4404 for ISE majors).
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGE 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Industrial and Systems Engineering

Our Website (http://www.ise.vt.edu)

Overview

The mission of the Grado Department of Industrial and Systems Engineering is to:

- Prepare undergraduate and graduate students for life-long success and leadership in the profession, in industry, and in higher education;
- Conduct and disseminate research that advances knowledge; and
- Serve the profession, industry, and society.

Industrial and systems engineering is one of the most diverse fields in engineering. ISE is concerned with the design, improvement, and installation of integrated work systems of people, materials, equipment and technology, processes, information, and capital. The industrial engineer is concerned with creating value and improving performance of integrated systems, whether that involves improving quality and productivity, reducing costs and non-value adding activities, improving customer satisfaction, or improving worker safety.

The applications for industrial engineering capabilities include industry, government, and service organizations. Graduates of the ISE program at Virginia Tech work in manufacturing facilities, distribution warehouses, hospitals, airlines, railroads, banks, amusement parks, the military, federal government, and management consulting firms. The boundaries of where ISEs make contributions are limitless.

The mission of the ISE Undergraduate Program is to prepare industrial and systems engineering students to create value for organizations, the profession, and society. We achieve this mission by recruiting, retaining, and educating high quality and diverse students and by creating a rigorous and collegial environment enabling students to learn industrial engineering methods and tools, built upon a foundation of mathematical, physical, and engineering sciences, and to apply them in any global organizational setting. Students are able to achieve academic and professional success through opportunities to participate in various educational experiences, to develop capabilities as future leaders, and to embark on a lifelong journey of professional development and learning.

Program Educational Objectives and Student Learning Outcomes

The ISE faculty, with input from our external Advisory Board, employers, and students, have defined the following Program Educational Objectives (PEOs) and Student Outcomes for our Undergraduate Program. PEOs are statements that describe the expected accomplishments of ISE graduates within 3-5 years after graduation. Student Outcomes are statements that describe what students are expected to know and be able to do at the time of graduation.

Program Educational Objectives: Within 3-5 years of graduation, ISE alumni will have:

- Created value by applying industrial and systems engineering methods to complex challenges, with critical thinking, creativity and innovation, to design integrated systems and implement sustainable solutions.
- Provided technical or programmatic leadership.
- Pursued professional development activities for the pursuit of knowledge and curiosity in existing specialty areas or emerging trends.
- Communicated effectively with relevant audiences and stakeholders, using written, oral, and visual media.
- Worked effectively and inclusively in teams having attributes such as diverse backgrounds, organizational experience, geographic locations, and demographic compositions.
- Served the profession, alma mater, community, and society as exemplified by our motto *Ut Prosim* (That I May Serve).

Student Learning Outcomes: At the time of graduation, ISE students will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Industrial and Systems Engineering program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Industrial and Similarly Named Engineering Programs .

Curriculum

The BSISE curriculum (ISE Undergraduate Program) encompasses coursework addressing the technical, organizational, human, and economic elements of work systems. Our aim is to provide graduates with the knowledge and capabilities to enable them to successfully pursue careers in industrial engineering or to continue on to graduate study.

ISE emphasizes instruction in fundamental engineering principles based on the physical sciences, engineering sciences, mathematics, and statistics. These principles are applied in practical design experiences throughout the undergraduate curriculum.

Coursework in the physical sciences and mathematics provides a solid background for basic engineering science courses, which in turn support courses in industrial engineering. Industrial engineering courses are focused in the areas of operations research, manufacturing systems, human factors and ergonomics, and management systems. In each of these areas, modern computing and software tools support analysis and design activities. Electives provide students with the opportunity to explore other areas of engineering, as well as cultural, societal and creative experiences, which makes for well-rounded, diverse, and globally-aware engineers.

Students gain valuable hands-on experience in multiple areas of the BSISE curriculum via state-of-the-art laboratory facilities. These include the Harris Manufacturing Processes Laboratories (conventional and numerically-controlled machine tools, robotics and automation equipment, and welding and foundry facilities), the Learning Factory (Industry 4.0 sandbox laboratory for undergraduates), and the Human Factors Work Measurement and Methods Engineering Laboratory (equipment for in-class exercises and experiments in work measurement, motion economy and time study, psychophysics, human audition and vision, and work station design).

The capstone experience in the ISE Undergraduate Program is ISE 4005-ISE 4006 Project Management & System Design (also referred to as "Senior Design"). The two-course sequence involves students working in project teams with external company sponsors to solve real-world problems. This provides ISE students with engineering project experience that develops not only their capabilities in applying ISE tools and techniques, but technical and professional skills such as teamwork, communication, project management, and life-long learning skills as well. Student project teams present their findings at the annual Senior Design Symposium, which is attended by company sponsors and the ISE Advisory Board.

Many ISE students participate in Undergraduate Research to help satisfy elective requirements in the curriculum. The opportunity to work more closely with ISE faculty members, in some cases on a one-on-one basis,

can provide more in-depth development of particular ISE capabilities and a more-enriching educational experience.

The ISE program also provides students with the opportunity to pursue minors, such as a Business Minor, Green Engineering Minor, or Statistics Minor. Specific information about minors available to ISE students can be found on the ISE website. Students and employers alike are seeing the benefits of these minors for adding value to the ISE major.

The ISE department participates in the Cooperative Education & Internship Program, in which qualified students may alternate semesters of study with semesters of professional co-op employment or internships. Students are encouraged to pursue these experiences before they graduate to make them more competitive in the work force. Students are also encouraged to participate in career fairs and job interviews on and off campus.

The ISE department also provides students with many significant scholarship opportunities at the undergraduate and graduate levels to encourage and acknowledge high academic performance and achievements. The department also maintains bilateral student exchange agreements with international universities, where students can take ISE courses, which will transfer back to their BSISE. Students may also select other universities at which to perform a study abroad semester.

The ISE department also provides students with many significant scholarship opportunities at the undergraduate and graduate levels to encourage and acknowledge high academic performance and achievements. The ISE department also maintains bilateral student exchange agreements with international universities, where students can take ISE courses which will transfer back to their BSISE. Students may also select other universities at which to perform a study abroad semester.

Program Requirements

Students are strongly encouraged to meet with one of the ISE Academic Advisors to discuss the BSISE curriculum.

- Industrial and Systems Engineering Major (p. 896)

Head: E.M. Van Aken
Associate Head: J.P. Shewchuk
Assistant Head and Graduate Program Director: M.A. Nussbaum
Undergraduate Program Director: N. Cherbaka
Charles O. Gordon Professor: G.D. Taylor, Jr.
Hal G. Prillaman Professor: M.A. Nussbaum
Paul T. Norton Professor: S.C. Sarin
Ralph H. Bogle Professor: Z. Kong
John Lawrence Professor: K.P. Triantis
Professors: P. A. Beling, J.L. Gabbard, M. Jeon, B.M. Kleiner, Z. Kong, M.L. Madigan, M.A. Nussbaum, S.C. Sarin, G.D. Taylor Jr., K.P. Triantis, K.L. Tsui, and E.M. Van Aken
Associate Professors: M. Bansal, X. Chen, D.E. Dickerson, K.P. Ellis, N. Ghaffarzadegan, R. Jin, B. Johnson, S.G. Klauer, A. L'Afflitto, N. Lau, P.K. Rao, J.P. Shewchuk, and E.B. Toy
Assistant Professors: R. Hildebrand, N. Hosseinichimeh, R. Kannan, S. Khodadadian, S. Lim, R.N.C. Patrick, T.G. Topcu, S. Tunc, and H. Zhong
Visiting Assistant Professor: B. Song
Collegiate Full Professor: N. Cherbaka
Collegiate Assistant Professors: K. Carper, J. Godfrey, W.P.V. Nguyen, and L. Savage
Research Associate Professor: S. Kim. T. Sun
Research Assistant Professor: K. Lee
Associate Professor of Practice: M.R. Earnest
Faculty Affiliates: P. Agee, T. Cody, X. Deng, M. Fowler, Y. Hong, S. Hotle, J. Moreland, M. Perez, N. Roofigari-Esfahan, S. Trent
Adjunct Faculty: M. Deegan, J. Geraghty, G. Keller, M. Muscatello, W. Vaneman, and P. Wach
Professors Emeritus: M.P. Deisenroth, W.J. Fabrycky, K.H.E. Kroemer, H.A. Kurstedt, H.D. Sherali, and H.L. Snyder
Associate Professors Emeritus: P. Ghare, P.T. Kemmerling P. Koelling, J.A. Nachlas, and R.E. Taylor
Academic Advisors: J. Kerstiens and P. Van Curen

Undergraduate Course Descriptions (ISE)

ISE 2004 - Introduction to Industrial and Systems Engineering (1 credit)
Introduction to the Industrial and Systems Engineering profession through exposure to problems, principles, and practice. Systems thinking, critical thinking, and contemporary issues in industrial and systems engineering. Introduction to the ISE Department, focusing on faculty and research areas. Importance of ethics and professionalism. Academic planning for the BSISE degree.
Instructional Contact Hours: (1 Lec, 1 Crd)

ISE 2014 - Engineering Economy (2 credits)
Concepts and techniques of analysis for evaluating the value of products/services, projects, and systems in relation to their cost. Economic and cost concepts, calculating economic equivalence, comparison of alternatives, purchase versus lease decisions, financial risk evaluation, cash flow sensitivity analysis, and after-tax analysis.
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 2024 - Probability Foundations for Industrial and Systems Engineers (3 credits)
Introduction to the mathematical foundations of probability theory for industrial engineers. Understanding of probability as a model for real phenomena, with applications of probability in an industrial engineering context. Review of set theory, counting (permutations and combinations), definition of probability axioms, sample spaces, random variables, independence, probability distribution functions, probability mass or density functions, expectations, moment-generating functions, joint and conditional random vectors and distributions, and distributions of functions of random variables, central limit theorem.
Prerequisite(s): MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2034 - Data Management for Industrial and Systems Engineers (3 credits)
Investigation of data modeling, storage, acquisition, and utilization in industrial and systems engineering. Development of effective spreadsheet applications. Design and implementation of relational databases via entity-relationship modeling, relational schema, normalization, and queries. Structured query language (SQL) fundamentals and SQL relational databases. Overview of non-relational databases, Big Data, and Data Analytics. All topics covered within the context of typical industrial and systems engineering problems.
Prerequisite(s): CS 1044 or CS 1064 or CS 1114 or ECE 1574
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2044 - Careers in Industrial and Systems Engineering (1 credit)
Overview of the breadth of careers and professional opportunities in the field of industrial and systems engineering. Technical approaches and solutions, emerging trends, career progression, and leadership aspects of industrial and systems engineering practice. Representation of practice across all areas of industrial and systems engineering as well as across a range of industries.
Instructional Contact Hours: (1 Lec, 1 Crd)

ISE 2214 - Manufacturing Processes Laboratory (1 credit)
Laboratory exercises and experimentation in manufacturing processes. Emphasis on using production machines and equipment to make products using multiple manufacturing processes, coupled with inspection per engineering drawings. Processes include assembly, casting, machining, forming, welding, and non-traditional machining, performed manually and/or via computer programming. Also covers basic shop floor operation and documents used for monitoring and controlling part production.
Instructional Contact Hours: (3 Lab, 1 Crd)

ISE 2404 - Deterministic Operations Research I (3 credits)
Deterministic operations research modeling concepts. Linear programming, integer programming, and non-linear programming modeling, assumptions, algorithms, modeling languages, and modern optimization software. Graphical solution, Simplex tableau method and its graphical interpretation. Branch and bound and branch and cut methods. Duality, sensitivity analysis, and Karush-Kuhn-Tucker (KKT) Optimality Conditions with economic interpretation. Network models (formulations and algorithms) including transportation problems, assignment problems, shortest path problems, maximum flow problems, minimum cost network flow problems, and minimal spanning tree problems.
Prerequisite(s): MATH 1114 or MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2804 - Foundations of Systems Engineering (3 credits)
A systems approach to designing, building, verifying, deploying, operating, and sustaining complex engineered systems. Emergent properties of systems, system lifecycle, and systems engineering as a process driven discipline. Technical management of processes regarding acquisition, contracting, and development. Problem formulation and elicitation of requirements. Creation of system elements: resource components, functions, internal and external interfaces. Introduction to decision analysis and risk management, model-based systems engineering and system architectures.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 3004 - Industrial Cost Control (3 credits)
Introduction to basic accounting concepts and operating characteristics of accounting systems. Principles of financial, cost and activity-based accounting, design of accounting systems, techniques of analysis, and cost control. Emphasis on interpretation of accounting for decision-analysis, including the benefits of limitations of accounting information.
Prerequisite(s): ISE 2014 or ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3034 - Technical Communication for Engineers (3 credits)
Fundamentals of effective technical writing. Structure, presentation, and utility of common engineering documents: laboratory reports, technical reports, proposals, progress reports, and project reports. Practice in writing common engineering documents, both individually and collaboratively. Strategies and practice for effective oral technical presentations, both individually and group-based. Ethical and legal considerations in technical writing and oral technical presentations. All topics covered within the context of typical engineering problems and practice.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3204 - Manufacturing Processes (3 credits)
Survey of manufacturing processes including casting, forming, machining, welding, joining, and nontraditional processes such as electrical-discharge machining. Basic manufacturing materials and their properties, structure of metals, metal deformation and heat treatment. Mathematical modeling of common manufacturing processes; process planning and the effect of plans on cost; impact of product design on manufacturability and assemblability. Recent trends in manufacturing, sustainable manufacturing. Also includes topics in inspection and testing, computer-aided manufacturing, and numerical control.
Prerequisite(s): ENGE 1216 or ENGE 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3214 - Facilities Planning and Logistics (3 credits)
Theory, concepts, and methods for designing and analyzing facilities and material flow in manufacturing, storage, and distribution environments. Topic areas include material handling systems, facility layout, facility location, warehousing, distribution, logistics, and transportation. C- or better in ISE 2014, 2404, and 3414.
Prerequisite(s): ISE 2014 and ISE 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3414 - Probabilistic Operations Research (3 credits)
This course introduces probability models used to investigate the behavior and performance of manufacturing and service systems under conditions of uncertainty. Major topics include probability, conditioning, elementary counting processes, and Markov chains and Markov processes. Emphasis is on the use of these tools to model queues, inventories, process behavior, and equipment reliability. C- or better required in STAT 4105, MATH 2224 or 2204, MATH 2214 or 2214H, and ISE 2004.
Prerequisite(s): ISE 2024 and (MATH 2204 or MATH 2204H or MATH 2406H) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3424 - Discrete-Event Computer Simulation (3 credits)
Analysis and design of work systems through static and dynamic simulation. Topics include an introduction to systems analysis and modeling, simulation optimization, model development and testing, and problem analysis through simulation. C- or better required in ISE 3414 and STAT 4105.
Prerequisite(s): ISE 3414
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ISE 3434 - Deterministic Operations Research II (3 credits)
Advanced concepts in deterministic operations research, including theory of complexity, integer programming, advanced linear programming techniques, nonlinear programming, dynamic programming. Covers modeling languages and optimization software for integer programming and nonlinear programming problems. Grade of C- or better required in ISE 2004, 2404 and MATH 2204 or 2224.
Prerequisite(s): ISE 2404 and (MATH 2224 or MATH 2204) and ISE 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3614 - Human Factors Engineering and Ergonomics (3 credits)
Investigation of human factors, ergonomics, and work measurement engineering, with emphasis on a systems approach toward workplace and machine design. Discussion of basic human factors research, discipline-specific ethics, design/evaluation methods for industrial and artificial intelligence (AI) systems including human machine interactions, human information processing, visual and auditory processes, design of display and control, effects of environmental stressors on humans, visualization and sonification of large datasets, human factors role in the design of machine learning and AI applications.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 3624 - Industrial Ergonomics (3 credits)
Introduction to ergonomics and work measurement with an emphasis on people at work. Discussion of methods for work measurement, ergonomic assessment, and evaluation, with major topics including productivity and performance, manual materials handling, work-related musculoskeletal disorders, safety, training and legal issues. C- or better required in ISE 3614.
Prerequisite(s): ISE 3614 and ESM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4004 - Theory of Organization (3 credits)
A theory of cooperative behavior in formal organizations, including the structure and elements of formal organizations. The executive process and the nature of executive responsibility also are examined.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4005 - Project Management and Systems Design (2 credits)
Capstone design experience for ISE majors. 4005: Structured systems engineering and project management methods and tools to plan, manage, and execute technical industrial and systems engineering projects. Students work in teams to apply industrial and systems engineering and project management tools to define and analyze a real-world problem and communicate results effectively. 4006: Designing, implementing, and evaluating work system solutions, all via students working in teams. Communication of solutions to various project stakeholders.
Prerequisite(s): ISE 2034 and ISE 2214 and ISE 3034 and ISE 3214 and ISE 3424 and ISE 3624 and ISE 4204
Corequisite(s): ISE 4404
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 4006 - Project Management and Systems Design (2 credits)
Capstone design experience for ISE majors. 4005: Structured systems engineering and project management methods and tools to plan, manage, and execute technical industrial and systems engineering projects. Students work in teams to apply industrial and systems engineering and project management tools to define and analyze a real-world problem and communicate results effectively. 4006: Designing, implementing, and evaluating work system solutions, all via students working in teams. Communication of solutions to various project stakeholders.
Prerequisite(s): ISE 4005
Instructional Contact Hours: (2 Lec, 2 Crd)

ISE 4014 - Introduction to Management Systems (3 credits)
Introduction to a systems approach for the design and improvement of management systems used in organizations. Discussion of organizational improvement approaches to improve the design and operation of management systems used in managerial decision-making. Analysis of success and failure of organizational improvement projects. Discussion of performance measurement systems, evaluation, and assessment tools.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4015 - Management Systems Theory, Applications, and Design (3 credits)
Systems approach to management, domains of responsibility, structured and synergistic management tools, management system model, contextual frameworks, information portrayal, automation objectives model, evaluation, shared information processing, information modeling. A management process for definition, measurement, evaluation and control, the organization as an information processor, corporate culture, scoping agreements, schemas and management elements, structured design.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4204 - Production Planning and Inventory Control (3 credits)
Planning and control of operations in both manufacturing and service industries. Management and utilization of resources to support cost effective products and services. Principles, models, and techniques used for production planning and inventory control.
Prerequisite(s): ISE 2404 and ISE 3414 and STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4214 - Lean Manufacturing (3 credits)
Overview of Lean Manufacturing principles, theory, methods, and techniques in modern manufacturing enterprises. Lean philosophy and basic concepts, master production scheduling and production smoothing, assembly line sequencing, setup time reduction, U-shaped line balancing/operation, machine arrangement, kanban, autonomation, and value stream mapping. Investigation and discussion of lean manufacturing case studies. C- or better required in ISE 4204.
Prerequisite(s): ISE 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4264 - Industrial Automation (3 credits)
Survey of various technologies employed in industrial automation, with emphasis on industrial applications of robotics, machine vision and learning, and programmable controllers. Introductory robot motion modeling, investigation into problems in Computer- Aided Design (CAD)/Computer-Aided Manufacturing (CAM) integration. Examination of components commonly employed in automation systems, their aggregation, and related production process design.
Prerequisite(s): ISE 3204 or ISE 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ISE 4304 - Global Issues in Industrial Management (3 credits)
Industrial management topics of current interest explored from a global perspective. Current domestic and international challenges resulting from a global marketplace and the proliferation of information and technology. Industrial management and organizational performance, total quality management, business process re-engineering, leadership, organizational change, role of communication and information, and ethics. Examination and comparison across international boundaries.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4404 - Statistical Quality Control (3 credits)
Application of statistical methods and probability models to the monitoring and control of product quality. Techniques for acceptance sampling by variables and attributes. Shewhart control charts for both mean and range of quality characteristics. Design of experiments and analysis of variance for effective data-generation processes. Motivation behind, and theoretical development and application of, both control charts and design of experiments. Design of effective quality control procedures.
Prerequisite(s): ISE 3414 and STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4414 - Industrial Quality Control (3 credits)
Implementation of statistical quality control techniques in an industrial setting. Development and analysis of cost models for use in the design of optimal quality control plans. Also included are new techniques, advanced quality control models, and an examination of the role of industrial statistics in the overall product quality assurance function. C- or better required in ISE 4404.
Prerequisite(s): ISE 4404
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4424 - Logistics Engineering (3 credits)
Introduction to the key issues in the integrated support of a product or process. Synthesis of topics from earlier studies to provide a cohesive approach to their applications. Logistics engineering provides a survey of product support issues and methods of resolving them within the context of the overall production activity. C- or better required in ISE 3414.
Prerequisite(s): ISE 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4434 - Supply Chain and Operations Engineering (3 credits)
Mathematical models, algorithms, and tools to support the design/redesign and management of supply chain systems. Resiliency, reliability, efficiency, and effectiveness of supply chains; collaboration and coordination among the different decision-makers in supply chains; impact of new developments on supply chain engineering, including the growth of the internet and e-commerce, the need to build suitable and environmentally-friendly supply chains. Mathematical modeling and system-wide optimization of the entire supply chain system under certainty.
Prerequisite(s): ISE 2404 and ISE 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4624 - Physical Work Assessment (3 credits)
Physical ergonomics assessment methods, including cardiorespiratory testing, metabolic energy expenditure and balance, strength, anthropometry, endurance and fatigue, electromyography, biomechanics, thermal stress.
Prerequisite(s): ISE 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4634 - Human Factors in Transportation (3 credits)
Introduction to human factors principles applied to surface transportation for industrial engineers. Understanding of human factors research methods, with applications for safety to the transportation system. Haddon's Matrix, human factors research methods, crash countermeasures, public policy implications, and automated driving systems.
Prerequisite(s): ISE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4644 - Risk and Hazard Control (3 credits)
Introduction to the fields of risk assessment, risk and hazard control, safety management, process safety, and system safety engineering through exposure to problems, principles, and practice. Integrated systems approach to problem solving. Industrial accident and disaster case study analysis and review of contemporary issues. Review of risk analysis and control techniques and overview of global regulations and guidelines for process, industrial, and occupational safety. C- or better required in ISE 3614.
Prerequisite(s): ISE 3614
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4654 - Principles of Industrial Hygiene (3 credits)
Introduction to the foundations of the field of Industrial Hygiene, that discipline devoted to the anticipation, recognition, measurement, evaluation, and control of occupational health hazards. Includes biological (e.g. microbial agents, allergens), chemical (e.g. solvents, carcinogens, dusts), and physical (e.g. radiation , temperature) hazards. Overview of control of health hazards, such as personal protective equipment, administrative controls, and engineering controls. Will involve lecture and participatory case-study activities. Will provide ample opportunity for hands-on use of monitoring equipment, protective equipment and controls testing devices.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4804 - System Dynamics Modeling of Industrial Systems (3 credits)
Computer-aided approach to analyze and make better decisions in complex industrial systems. Systems thinking and causal loop modeling of complexity over time. Interconnectivity of industrial systems, production, and service. Stock-flow diagrams. Systems modeling of product development and market adoption. Simulation of dynamic problems arising in complex systems. Systems modeling and simulation-based decision analysis to improve performance in service and manufacturing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ISE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ISE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ISE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Industrial and Systems Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ISE 2004	Introduction to Industrial and Systems Engineering	1
ISE 2014	Engineering Economy	2
ISE 2214	Manufacturing Processes Laboratory	1
ISE 2024	Probability Foundations for Industrial and Systems Engineers	3
ISE 2034	Data Management for Industrial and Systems Engineers	3
ISE 2404	Deterministic Operations Research I	3

ISE 3614	Human Factors Engineering and Ergonomics	3
ISE 3214	Facilities Planning and Logistics	3
ISE 3414	Probabilistic Operations Research	3
ISE 3424	Discrete-Event Computer Simulation	3
ISE 3624	Industrial Ergonomics	3
ISE 4204	Production Planning and Inventory Control	3
ISE 4005	Project Management and Systems Design	2
ISE 4404	Statistical Quality Control	3
ISE 4006	Project Management and Systems Design	2
Subtotal		38
Major Requirements		
ISE 2804	Foundations of Systems Engineering	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus (C-)	3
ESM 2104	Statics	3
STAT 4706	Probability and Statistics for Engineers	3
Career Bridge Experience [1]		
ENGE 3900	Bridge Experience	0
Electives		
Programming Elective		
Select one of the following:		3
CS 1044	Introduction to Programming in C (C-)	
CS 1064	Introduction to Programming in Python (C-)	
CS 1114	Introduction to Software Design (C-)	
ISE Technical Electives [2]		
Select nine credits from the following:		9
ISE 3004	Industrial Cost Control	
ISE 3204	Manufacturing Processes	
ISE 3434	DETERMINISTIC OPERATIONS RESEARCH II: Algorithms, Software, & ML	
ISE 4004	Theory of Organization	
ISE 4014	Introduction to Management Systems	
ISE 4214	Lean Manufacturing	
ISE 4264	Industrial Automation	
ISE 4304	Global Issues in Industrial Management	
ISE 4414	Industrial Quality Control	
ISE 4424	Logistics Engineering	
ISE 4434	Supply Chain and Operations Engineering	
ISE 4624	Physical Work Assessment	
ISE 4644	Risk and Hazard Control	
ISE 4654	Principles of Industrial Hygiene	
ISE 4804	System Dynamics Modeling of Industrial Systems	
ISE 4974	Independent Study	
ISE 4984	Special Study	
ISE 4994	Undergraduate Research	
Technical Electives [3]		
Select six credits [4]		6
Engineering Science Electives [5]		
Select one of the following:		3
ECE 3054	Electrical Theory	
ESM 2204	Mechanics of Deformable Bodies	
ESM 2304	Dynamics	
MSE 2034	Elements of Materials Engineering	
Free Electives [6, 7]		*3*
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ISE 3034	Technical Communication for Engineers (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215	Foundations of Engineering (6D)	2
ENGE 1216	Foundations of Engineering (6D)	2
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double-counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours		
Total Credits		**124**

1 Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BS ISE degree. Because some of these experiences are not credit bearing, the ENGE 3900 course is used to track and assess student participation in a Career Bridge Experience and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan. Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in ISE 2004.

2 The purpose of this requirement is to enable student to develop expertise in a particular area of the ISE discipline.

- Courses must be selected from the list provided. Course offerings are subject to change and the availability of sufficient resources: check the Timetable of Classes for actual course offerings each semester.
- A maximum of six (6) credits of ISE 4974 Independent Study or ISE 4994 Undergraduate Research is allowed without prior approval from the ISE Undergraduate Program Director.

[3] The purpose of this requirements is for students to further develop technical skills and to provide the opportunity to focus on a particular technical area by taking electives with significant technical content.
- The courses must be on an A-F basis, unless prior approval (for P/F basis) has been obtained from the ISE Undergraduate Program Director.
- Up to three (3) credits can be obtained via ISE Technical Elective courses not being used for ISE Technical Elective credit.

[4] Courses must be selected as follows:
- Any 3000 or 4000 level course from AOE, BMES, BSE, CEE, CEM, CHE, CHEM, CMDA, CS, ECE, ESM, MATH, ME, MSE, MINE, NSEG, PHYS, STAT **except** the following: CEE 4804 Professional and Legal Issues in Civil Engineering, CHEM 4014 Survey of Chemical Literature, CS 3604 Professionalism in Computing, CS 4214 Simulation and Modeling, MATH 4044 History of Mathematics, MATH 4625 Mathematics for Secondary Teachers, MATH 4626 Mathematics for Secondary Teachers, MATH 4644 Secondary School Mathematics With Technology, MATH 4664 Senior Math Education Seminar, ME 4454 Engineering Leadership in Practice:Managing the Technical Design Process, STAT 3005 Statistical Methods, STAT 3006 Statistical Methods, STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 3704 Statistics for Engineering Applications, STAT 4105 Theoretical Statistics, STAT 4604 Statistical Methods for Engineers, STAT 4705 Probability and Statistics for Engineers, STAT 4714 Probability and Statistics for Electrical Engineers
- ENGR 3124 Introduction to Green Engineering and/or ENGR 4134 Environmental Life Cycle Assessment
- Other courses are allowed only with prior approval from the ISE Undergraduate Program Director.

[5] The purpose of this requirement is for students to broaden their knowledge of engineering science outside ISE.
- Courses must be selected from the list below (unless prior approval has been obtained from the ISE Undergraduate Program Director.

[6] Students may not use a given course to satisfy both Free Elective and Pathways requirements: any given course can satisfy one requirement only.

[7] Only free electives and courses offered on a P/F basis only (e.g. FA 2004 Creativity and the Artistic Experience may be taken under the P/F grading option.)

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ISE Department fully supports this policy. In addition, upon completion of two semesters as an ISE major, students must have:

- a minimum in-major GPA of 2.00 or better (in-major GPA is determined from all ISE and required STAT classes);

Graduation Requirements

Each student must complete at least 124 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. (In-major GPA is determined from ISE and required STAT classes.)

Pre-requisites: Students must earn a C- or better in ISE, STAT, and MATH courses which are prerequisites for subsequent ISE courses, with the exception of ISE 2004, ISE 2014, and ISE 2214.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

Roadmap

First Year		
Fall Semester		**Credits**
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
ENGE 1215	Foundations of Engineering	2
Programming Elective		3
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**15**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
PHYS 2305	Foundations of Physics (w/ lab)	4
ENGE 1216	Foundations of Engineering	2
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**16**
Second Year		
Fall Semester		
MATH 2114	Introduction to Linear Algebra (C-)	3
MATH 2204	Introduction to Multivariable Calculus (C-)	3
PHYS 2306	Foundations of Physics (w/lab)	4
ISE 2004	Introduction to Industrial and Systems Engineering	1
ISE 2014	Engineering Economy	2
ISE 2214	Manufacturing Processes Laboratory	1
ISE 2804	Foundations of Systems Engineering	3
	Credits	**17**
Spring Semester		
ESM 2104	Statics	3
MATH 2214	Introduction to Differential Equations (C-)	3
ISE 2024	Probability Foundations for Industrial and Systems Engineers (C-)	3
ISE 2034	Data Management for Industrial and Systems Engineers (C-)	3
ISE 2404	Deterministic Operations Research I (C-)	3
ISE 3614	Human Factors Engineering and Ergonomics (C-)	3
	Credits	**18**
Third Year		
Fall Semester		
STAT 4706	Probability and Statistics for Engineers (C-)	3
ISE 3034	Technical Communication for Engineers (C-)	3
ISE 3214	Facilities Planning and Logistics (C-)	3
ISE 3414	Probabilistic Operations Research (C-)	3

Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**15**
Spring Semester		
ISE 3424	Discrete-Event Computer Simulation (w/ Lab, C-)	3
ISE 3624	Industrial Ergonomics (C-)	3
ISE 4204	Production Planning and Inventory Control (C-)	3
ISE Technical Elective		3
Engineering Science Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
ISE 4005	Project Management and Systems Design (C-)	2
ISE 4404	Statistical Quality Control	3
ISE Technical Elective		3
Technical Elective		3
Select three credits from Pathways 2, 3, 6A or 7		3
ENGE 3900	Bridge Experience	0
	Credits	**14**
Spring Semester		
ISE 4006	Project Management and Systems Design	2
ISE Technical Elective		3
Technical Elective		3
Free Elective		3
Select three credits from Pathways 2, 3, 6A or 7		3
	Credits	**14**
	Total Credits	**124**

Materials Science and Engineering

Our Website (http://www.mse.vt.edu)

Overview

Materials engineers and scientists study the structure and properties of engineering materials on scales ranging from the atomic through the microscopic to the macroscopic. These materials include ceramics and glasses, metals, polymers, composites, biomaterials, nanomaterials, semiconductors, and electronic, magnetic, and photonic materials. Materials engineers develop new materials, improve traditional materials, and manufacture materials economically through synthesis, processing, and fabrication. They seek to understand physical and chemical phenomena in material structures and to measure and characterize materials properties of all kinds including mechanical, electrical, optical, magnetic, thermal, and chemical. They predict and evaluate the performance of materials as structural or functional elements in engineering systems and structures. They work in teams with engineers in other disciplines in selecting, designing and processing materials for optimal performance.

Significant opportunities exist for graduates in the aerospace, automobile, transportation, medical, microelectronics, telecommunications, chemical, petroleum, energy storage, power generation, and energy conservation industries, as well as within the basic industries producing materials--for example, the copper, aluminum, steel, ceramics, glass, and polymer industries. Opportunities also exist in government-operated engineering centers and research laboratories. Graduates work in entry level engineering, manufacturing, materials selection and design, quality assurance and control, research and development, technical consulting, management, and sales and marketing. Graduates have an excellent background for continuing education in science, engineering, medicine, law (e.g. patent law), and business.

Accreditation, Program Educational Objectives, and Student Outcomes

Accreditation

The B.S. in MSE degree program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org, under the commission's General Criteria and the Program Criteria for Materials, Metallurgical, Ceramics and Similarly Named Engineering Programs.

Program Educational Objectives

The goal of the BS degree program in MSE is to provide the educational foundation that enables alumni to pursue their personal career objectives. Historically, the majority of our alumni become valued members of industrial and/or research teams within the field of materials science or related technical disciplines while a smaller percentage pursue graduate education or other personal career objectives.

The specific program educational objectives for the BS degree program in MSE are to produce alumni who are:

- effective communicators with written, oral, and visual media:
- able to apply critical thinking skills to engineering and research problems: and
- effective learners able to apply technical tools, techniques, and knowledge specific to their field of employment or graduate studies.

Student Learning Outcomes

Upon graduation, students completing the B.S. degree program in MSE will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum

Students typically enter the MSE Department following completion of their first-year studies within the College of Engineering, as administered by the Department of Engineering Education (ENGE); a description of required first year coursework can be found within the ENGE section of this catalog.

In addition to foundation courses in MSE, students tailor an individualized program of elective study. 12 credits of technical electives will be selected to emphasize certain subdisciplines of MSE (e.g., metals, ceramics, polymers, electronic materials, composites, biomaterials, nanomaterials, etc.) or to prepare for a career in an engineering application area. Course-work totals 126 credit hours as detailed in the University Catalog at Program Explorer | Virginia Tech (https://catalog.vt.edu/program-explorer/).

The undergraduate curriculum contains a nationally recognized integrated program of instruction in engineering communication including writing, public speaking, proposal preparation, reporting, research skills, critical and creative thinking, and graphical presentation. More information regarding this unique program can be found at https://mse.vt.edu/Programs.html

The undergraduate program culminates with a two-semester team-oriented engineering design capstone project in which the students address a significant problem in their area of special interest.

The MSE students have pursued various minors including Green Engineering, Chemistry, Mathematics, Music, Nuclear, and various others.

Educational Enhancement Opportunities

Students of MSE can participate in the cooperative education program in which qualified students may alternate semesters of study with semesters of professional employment. (www.career.vt.edu/experience/ceip.html (http://www.career.vt.edu/experience/ceip.html))

MSE also participates in the university honors degree options (see www.honorscollege.vt.edu (http://www.honorscollege.vt.edu)).

Study abroad opportunities are also available Studying Abroad | Global Education Office | Virginia Tech (https://www.globaleducation.vt.edu/students/Outbound.html).

- Materials Science and Engineering Major (p. 905)
- Materials Science and Engineering Major with Nuclear Materials Option (p. 908)

Head: S.G. Corcoran (interim)
Jack E. Cowling Professor: D.D. Viehland
Professors: S.K. Kodambaka, G.Q. Lu, M. Murayama, G.R. Pickrell, and W.T. Reynolds Jr.
Associate Professors: A.O. Aning, L.V. Asryan, W. Cai, S.G. Corcoran, C. Hin, A.R. Whittington[1], and H. Yu.
Assistant Professors: X. Bai, T. Pham, C. Tallon, and T. Rost
Collegiate Associate Professor: T.W. Staley
Collegiate Assistant Professor: H. Kindlund and H.M. Elmkharram
Associate Professors of Practice: A.P. Druschitz, and S. McGinnis
Assistant Professor of Practice: C.B. Burgoyne
Research Associate Professors: J-F. Li and C.T.A. Suchicital
Research Assistant Professor: Y. Zhu
Instructors: R. Clark, and W.C. Hill
Professors Emeritus: J.J. Brown Jr., R.O. Claus, N.E. Dowling, D. Farkas, G.V. Gibbs, D.P.H. Hasselman, and R.W. Hendricks
Affiliated Faculty: R.C. Batra, M.J. Bortner, A. Brand, S.W. Case, R.V. Davalos, C. DiMarino, P. Dove, S. Emori, Y. Fu, A. Goldstein, J.R. Heflin, X. Jia, B. Johnson, B. Lattimer, G. Liu, F. Lin, R. Mahajan, R.B. Moore, A. Morris, K. Ngo, K. Park, L. Quan, N.L. Ross, J. Song, M. Van Dyke, C.B. Williams, R.H. Yoon, and Y. Zhang.

E-mail: mseadvising@vt.edu

Undergraduate Course Descriptions (MSE)

MSE 1004 - Materials In Todays World (1 credit)
An introductory course designed for the student with a basic high school science background who wishes to understand and learn about the exciting materials developments which are affecting us all in todays world. The course will introduce the structures and properties of metals, ceramics, polymers (plastics), composites, and materials for electronic and optical applications. Students will also gain an appreciation for the processing and design limitations of materials used in everyday applications.
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 1014 - The Science of Materials in Everyday Life (3 credits)
Introduction to the science of materials using everyday applications in modern society from medicine, transportation, sports, art, music, infrastructure, and electronics. Discussion of metals, ceramics, plastics, biomaterials, and hybrid materials based on the fundamental science dictating their structure properties, and processing. Considerations of tradeoffs between environmental sustainability, ethical and societal issues, and economics for materials choices.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2014 - Materials Engineering Transition (1 credit)
Supplemental coverage of introductory topics not included in courses delivered to non-MSE majors.
Prerequisite(s): MSE 2034 or MSE 3094 or AOE 3094
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2034 - Elements of Materials Engineering (3 credits)
This course is designed to introduce the non-MSE student to the structures and properties of metals, ceramics, polymers, and composites. In addition, students will gain an understanding of the processing and design limitations of these materials, as well as being introduced to new classes of materials being developed to meet the ever expanding range of material requirements. Non-MSE majors only.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2044 - Fundamentals of Materials Engineering (4 credits)
This course is designed to introduce the MSE major to the structures and properties of metals, ceramics, polymers, composites, and electronic materials. Students will also gain an understanding of the processing and design limitations of materials. Topics fundamental to the further study of materials, such as crystal structures, phase diagrams, and materials design and processing will be emphasized as foundations for future MSE courses.
Prerequisite(s): CHEM 1035
Corequisite(s): PHYS 2305
Instructional Contact Hours: (4 Lec, 4 Crd)

MSE 2054 - Fundamentals of Materials Science (3 credits)
Introduces MSE majors to fundamental underlying concepts governing phase equilibrium, microstructure, electronic properties of materials, and transport phenomena as a foundation to understanding materials behavior and processing.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 2114 - Math Programming MSE I (1 credit)
Basic computational and graphical functions in mathematics oriented programming languages using data and engineering examples from the field of Materials Science. Students apply general methods to problems of their choice through mini- projects.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2884 - Materials Engineering Professional Development I (1 credit)
Topics on professional, communications, and leadership skills in entering the engineering workplace; building and presenting qualifications for professional development; expanding the professional network; and ethical, diversity, inclusion, and equity in the engineering workplace. Career gap analysis, team dynamics, resumes, job interviews, cover letters, scholarship essays, personal statements, professional development portfolios, case studies, poster presentations. Pre: Sophomore standing in the MSE major.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2984D - Special Study (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

MSE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 3044 - Transport Phenomena in MSE (3 credits)
Mass transport (continuum and atomistic diffusion), heat transport and fluid flow (momentum transport). Analytical and computer based methods for solving transport problems.
Prerequisite(s): MSE 2044 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3054 - Mechanical Behavior of Materials (3 credits)
Mechanical properties and behavior of engineering materials subjected to static, dynamic, creep, and fatigue loads under environments and stress states typical of service conditions; biaxial theories of failure; behavior of cracked bodies; microstructure-property relationships and design methodologies for homogeneous and composite materials.
Prerequisite(s): ESM 2204 and (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 3054

MSE 3064 - Mechanical Behavior of Materials Laboratory (1 credit)
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers.
Prerequisite(s): ESM 2204
Corequisite(s): MSE 3054
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ESM 3064

MSE 3104 - Mineralogy (3 credits)
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester.
Prerequisite(s): CHEM 1035 or CHEM 1055 or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOS 3504

MSE 3114 - Mathematics Programming in Materials Science II (1 credit)
Advanced computational and graphical methods in mathematics oriented programming languages. Students develop programs that solve and/or provide visualizations of solutions to materials science and engineering problems.
Prerequisite(s): MSE 2114
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 3134 - Crystallography and Crystal Structures (3 credits)
Provides a comprehensive foundation in crystallography including lattices, point groups, space groups, reciprocal lattices, properties of x-rays, and electron density maps, all leading to a formal description of structures and an interpretation of the published crystallographic data.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3204 - Fundamentals of Electronic Materials (3 credits)
Introduction to the electrical, magnetic, and optical properties of solid-state materials. Development of atomic scale models for physical phenomena that are observable at the macroscopic scale. Connection is made between basic materials properties and the operational characteristics of selected solid-state devices.
Prerequisite(s): MSE 2054 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3304 - Physical Metallurgy (3 credits)
Deformation of crystalline solids and its relationship to crystal structure and crystal defects: crystal structures of metals, dislocations and plastic deformation, vacancies, recovery, recrystallization, grain growth, deformation twinning and martensite.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 3314 - Materials Laboratory I (1 credit)
Sample preparation for materials characterization techniques including various types of microscopy, spectroscopy, diffraction, and hardness testing. Instruction in the use of heat treating equipment and polishing and chemical etching procedures.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 3324 - Elementary Metal Casting Laboratory (1 credit)
Introduction to metal casting processes; gating, risering, molding and puring. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required.
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): MSE 3354
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 3334 - Test Methods for Foundry Laboratories (2 credits)
The properties of foundry sand, molten metal and castings are measured using standard laboratory test procedures. Safe foundry practices are emphasized. Oral and written reports are required.
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): MSE 3354
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

MSE 3354 - Foundry Safety (1 credit)
Provides comprehensive training in foundry safety procedures and policies. (May register multiple times).
Prerequisite(s): (MSE 2034 or MSE 2044) and ISE 2214
Corequisite(s): 3324 or 3334 or 4324.
Instructional Contact Hours: (2 Lec, 1 Crd)

MSE 3884 - Materials Engineering Professional Development II (1 credit)
Teamwork, ethical, professional, and communication practices in collaborative engineering environments; identification of areas of interest for potential senior design capstone projects; discipline-specific preliminary research in preparation for senior design projects: motivations and needs identification, broader impact (economic, social, environmental, and global), relevant theoretical concepts and methodologies, ethical engineering considerations, management logistic such identification of facilities and equipment, risk and safety analysis, critical paths and project timelines; basic project and time management; collaborative communications in written and oral form, personal professional development plans. Extends the basic treatment of these topics given in MSE 2884. Pre: Junior standing in the MSE major.
Prerequisite(s): MSE 2884
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 3954 - Study Abroad (1-6 credits)
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

MSE 4034 - Thermodynamics of Materials Systems (3 credits)
Topics in thermodynamics on the solution of materials selection and design related problems such as materials stability at high temperatures and in corrosive chemical environments. Thermodynamic principles important in controlling equilibrium in single component systems and multicomponent solid solutions and in establishing the thermodynamic driving force in kinetic processes which are important in materials processing unit operations. Estimation of thermodynamic properties and equilibrium calculations in multicomponent and multiphase systems.
Prerequisite(s): MSE 2044
Corequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4044 - Powder Processing (3 credits)
Processing methods associated with powder synthesis, characterization, colloidal processing, and forming of powder compacts. Theory of solid state and liquid phase sintering.
Prerequisite(s): MSE 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4055 - Materials Selection and Design I and II (3 credits)
4055: Selection of materials for engineering systems, based on constitutive analyses of functional requirements and material properties. 4056: The role and implications of processing on material selection.
Prerequisite(s): (MSE 3204 and MSE 3304) or (MSE 3204 and MSE 4414) or (MSE 3204 and MSE 4554) or (MSE 3304 and MSE 4414) or (MSE 3304 and MSE 4554) or (MSE 4414 and MSE 4554)
Corequisite(s): MSE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4056 - Materials Selection and Design I and II (3 credits)
4055: Selection of mateials for engineering systems, based on constitutive analyses of functional requirements and material properties. 4056: The role and implications of processing on material selection.
Prerequisite(s): MSE 4055
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4075 - Senior Design Laboratory (1 credit)
A capstone design course centered around an open-ended, faculty-advised senior project involving the design of a process, material, or a technique for solving a technological problem. Senior standing in MSE required.
Prerequisite(s): MSE 4644
Corequisite(s): MSE 4055, MSE 4085
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4076 - Senior Design Laboratory (2 credits)
A capstone design course centered around an open-ended, faculty-advised senior project involving the design of a process, material, or a technique for solving a technological problem. Senior standing in MSE required.
Prerequisite(s): MSE 4075
Corequisite(s): MSE 4086
Instructional Contact Hours: (6 Lab, 2 Crd)

MSE 4085 - Senior Capstone Recitation (2 credits)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 3884
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MSE 4085H - Senior Capstone Recitation (2 credits)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 3884
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Instructional Contact Hours: (2 Lec, 2 Crd)

MSE 4086 - Senior Capstone Recitation (1 credit)
Topics in engineering professional practice, project planning and reporting, including discussion and presentation of proposals, interim and project reports. Instruction in environmental, social, and economic impacts of engineering; design theory and analysis; ethics, continuous learning, and global issues. Capstone course runs in parallel with faculty-advised Senior Design Laboratory. 4085: Emphasis on project planning and management techniques, teamwork strategies, literature research, and technical communication style. 4086: Continuing development of technical documents, with emphasis on professional communication to various audience formats. Additional focus on broader impacts of technical projects, including social, economic, environmental, ethical, and global contexts. Pre: Senior standing in MSE.
Prerequisite(s): MSE 4085
Corequisite(s): 4075 or 4095H for 4085; 4076 or 4096H for 4086. (2H,2C) for 4085. (1H,1C) for 4086.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

MSE 4095H - Honors Senior Design-Laboratory (3 credits)
Two-semester MSE capstone design course centered around an open-ended, faculty-advised senior honors project involving the design of a process, material, or a technique for solving a technological problem. Outcomes and work effort are consistent with that expected of honors students. MSE 4095H: Literature search, planning and proof-of-concept studies of assigned project. Individual preparation and presentation of an original senior honors thesis related to a team project in which the students also participate. Presentation of detailed project plan to faculty. MSE 4096H: Execution of proposed project, analysis of results and preparation of journal-quality presentation of results. Oral presentation of results to MSE faculty and students. Enrollment in University Honors and senior standing in MSE required.
Prerequisite(s): MSE 4644
Corequisite(s): MSE 4055, MSE 4085
Instructional Contact Hours: (9 Lab, 3 Crd)

MSE 4096H - Honors Senior Design Laboratory (3 credits)
Two-semester MSE capstone design course centered around an open-ended, faculty-advised senior honors project involving the design of a process, material, or a technique for a solving a technological problem. Outcomes and work effort are consistent with that expected of honors students. MSE 4096H: Execution of proposed project, anaylsis of results and preparation of journal-quality presentation of results. Oral presentation of results to MSE faculty and students. Enrollment in University Honors and senior standing in MSE required.
Prerequisite(s): UH 4095H
Corequisite(s): MSE 4086
Instructional Contact Hours: (9 Lab, 3 Crd)

MSE 4164 - Principles of Materials Corrosion (3 credits)
Introduction to the scientific principles of materials corrosion and corrosion protection. Topics include: thermodynamics of materials corrosion, including potential- PH (Pourbaix) diagrams, kinetics of corrosion reactions and mixed potential theory, types of corrosion (uniform, galvanic, crevice, pitting, fatigue, stress corrosion cracking, intergranular, and hydrogen embrittlement), material/environmental factors that promote or prevent the various types of corrosion, and methods and techniques of corrosion testing.
Corequisite(s): MSE 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4174 - Corrosion and Degradation of Materials Laboratory (1 credit)
Introduction to experimental techniques and principles used to study the effects of environmental exposure on various contemporary advanced materials systems. Emphasis on creation and measurement of property variations in engineered materials caused by time and chemical or energetic stimuli, and effective communication of these results.
Prerequisite(s): MSE 4034 and MSE 3314 and MSE 4424
Corequisite(s): MSE 3044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4224 - Electronic, Magnetic, and Optical Properties of Materials Laboratory (1 credit)
Introduction to experimental techniques used to study the electronic, magnetic, and optical properties of contemporary advanced materials systems; property variations made possible by composition and processing of engineered materials; and interaction of fields with materials – including effective communication of these results.
Prerequisite(s): MSE 3204 and MSE 3314 and MSE 4424
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4234 - Semiconductor Processing (3 credits)
Manufacturing practices used in silicon integrated circuit fabrication and the underlying scientific basis for these process technologies. Physical models are developed to explain basic fabrication steps, such as substrate growth, thermal oxidation, dopant diffusion, ion implantation, thin film deposition, etching, and lithography. The overall CMOS integrated circuit process flow is described within the context of these physical models.
Prerequisite(s): ECE 2214
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECE 4234

MSE 4304 - Metals and Alloys (3 credits)
This course covers the production, properties and uses of commercially important metals and alloys. The influence of structure, chemistry, and processing upon the properties of metals is emphasized. Alloy selection is discussed. Mechanical, electrical, thermal and chemical characteristics of ferrous and nonferrous alloys are studied.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4305 - Physical Metallurgy and Modeling of Metal Casting (3 credits)
4305: Casting processes; solidification and its influences on the structure and chemistry of castings; role of fluid flow and heat transfer in mold design; origin and control of casting defects. 4306: Design, layout, and modeling of metal components cast from aluminum, bronze, iron and steel; design of metal running systems; modeling of solidification process.
Prerequisite(s): MSE 3304
Corequisite(s): 3044 or ME 3304 for 4306.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4306 - Physical Metallurgy and Modeling of Metal Casting (3 credits)
4305: Casting processes; solidification and its influence on the structure and chemistry of castings; role of fluid flow and heat transfer in mold design; origin and control of casting defects. 4306: Design, layout, and modeling of metal components cast from aluminum, bronze, iron and steel; design of metal running systems; modeling of solidification processes.
Prerequisite(s): (MSE 2034 or MSE 2044) and MSE 3324
Corequisite(s): 3044 or ME 3304 for 4306.
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4314 - Bladesmithing (3 credits)
Introduction to bladesmithing processes. Hands-on experience with heating metal, visual temperature measurement, manual hammer forging, forge welding, cooling metal, and heat treatment. Emphasis on safe forging and bladesmithing practices.
Corequisite(s): MSE 3304, MSE 3354
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MSE 4324 - Advanced Metal Casting Laboratory (2 credits)
Advanced metal casting processes; no-bake sand molds; investment casting; rapid prototyping; melting and casting of aluminum, bronze, iron and steel. Casting finishing including shot and sand blasting. Hands-on experience. Emphasis on safe foundry practices. Oral and written reports are required.
Prerequisite(s): MSE 3324
Corequisite(s): MSE 3354
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MSE 4334 - Applied Materials Analysis (3 credits)
Fundamental materials theory applied to structure-property relationships in materials science and engineering through basic characterization techniques. Demonstrations, lab exercises, and practical application of modern characterization techniques such as Scanning and Transmission Electron Microscopy (SEM, TEM), Focused Ion Beam (FIB), and Atomic Force Microscopy (AFM).
Prerequisite(s): MSE 2044 and (MSE 3314 or MSE 4424)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MSE 4384 - Nuclear Materials (3 credits)
An introduction to materials for nuclear applications with emphasis on fission reactors. Fundamental radiation effects on materials; material properties relevant to structural, moderator, reflector, blanket, coolant, control shielding and safety systems; processes such as nuclear fuel cycles, fuel enrichment and reprocessing; and related structural systems.
Prerequisite(s): (MSE 3044 or ME 3304) and (MSE 3054 or ESM 3054 or ME 3614)
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4394 - Introduction to Molecular Dynamics Simulation (3 credits)
Background of molecular dynamics simulation method. Fundamental molecular dynamics principles, algorithms and components (atomic structure, periodic boundary conditions, interatomic potentials, equations of motion of atoms, statistical ensembles, integration of equations of motion). Implementation of algorithms into codes. Simulations of the time evolution of atoms, particles, or molecules under static or varying thermodynamic conditions and external loads. Connection between atom trajectories and evolution of the physical property of the simulation system with statistical mechanics principles. Hands-on case studies using molecular dynamics simulation package, LAMMPS. Prior knowledge of a programming language such as Fortran, C, C++, Matlab, Mathematica, Python, Java is highly recommended. Pre: Junior standing.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4414 - Physical Ceramics (3 credits)
Study of the relationships between the physical properties (thermal, optical, mechanical, electrical and magnetic) and the structure and composition of ceramics at the atomic and microscopic level as affected by processing and service environment. Emphasis will be placed on application and design using structural ceramics.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4424 - Materials Laboratory II (1 credit)
Processing and characterization of materials; exploration of the influence of processing parameters on physical and mechanical properties. Emphasis on material synthesis.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4434 - Ceramic and Glass Materials Processing Laboratory (1 credit)
Introduction to experimental techniques used to synthesize, process, and analyze resulting properties of ceramic and glass materials. Measurement of property variations made possible by changing composition and processing of engineered ceramic systems.
Prerequisite(s): MSE 4414 and MSE 3314 and MSE 4424
Instructional Contact Hours: (3 Lab, 1 Crd)

MSE 4544 - Laboratory In Polymer Science (2 credits)
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems.
Prerequisite(s): CHEM 3616 and CHEM 4534
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: CHEM 4074

MSE 4554 - Polymer Engineering (3 credits)
This course is designed to introduce the student to polymers from the MSE perspective. The basics of polymer syntheses and polymerization will be outlined. The relationship between processing, structure, and properties will be presented with respect to the performance and design requirements of typical polymer applications.
Prerequisite(s): MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4574 - Biomaterials (3 credits)
Materials for biomedical applications. Basic material types and properties, functional uses of materials in medical applications, and tissue response mechanisms. Integrated design issues of multicomponent material design in prosthetic devices for hard and soft tissues, orthopedics , cardiovascular, and drug delivery applications.
Prerequisite(s): MSE 2034 or MSE 2044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4574

MSE 4584 - Biomimetic Materials (3 credits)
Introduction to structure property relationships in biological materials such as wood, bone, shells, spider silk, connective tissue, blood vessels and jellyfish. Proteins and polysaccharides, biosynthesis and assembly, biomineralization, hierarchical organization. Introduction to tissue engineering and regenerative medicine. Life cycle, environmental aspects of biofabrication.
Prerequisite(s): (MSE 2034 or MSE 2044) and (CHEM 1036 or BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4604 - Composite Materials (3 credits)
The application of the fundamental concepts of mechanics, elasticity, and plasticity to multiphase and composite materials. Constitutive equations for the mechanical and physical properties of metal, ceramic, and polymeric matrix composites. The role of processing and microstructure on properties.
Prerequisite(s): (MSE 2034 or MSE 2044) and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4614 - Nanomaterials (3 credits)
Synthesis methods of 0D nanoparticles, 1D nanotubes/nanowires/ nanorods, 2D nanoribbons and nanofilms, and special nano-features on supports. Bottom-up and top-down approaches. Methods of characterization for nanomaterials. Processing of nanospecies into higher order dimensions; conventional processing techniques; techniques developed solely for nanomaterials. Chemical, physical, mechanical, and electrical properties of nanomaterials and applications of nanomaterials.
Prerequisite(s): MSE 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4644 - Materials Optimization Through Designed Experiments (3 credits)
Methods of analysis of variation in materials systems, manufacturing or R&D through the use of statistical methods including experimental design techniques. Instructional examples related to Materials Science and Engineering.
Prerequisite(s): MSE 3314 or MSE 4424
Instructional Contact Hours: (3 Lec, 3 Crd)

MSE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

MSE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MSE 29844 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Materials Science and Engineering Major

Code	Title	Credits
Degree Core Requirements		
MSE 2044	Fundamentals of Materials Engineering (C)	4
MSE 2054	Fundamentals of Materials Science	3
MSE 3044	Transport Phenomena in MSE	3
MSE 3134	Crystallography and Crystal Structures	3
MSE 3314	Materials Laboratory I	1
MSE 4034	Thermodynamics of Materials Systems	3
MSE 4424	Materials Laboratory II	1
Select one of the following:		3
MSE 4075 & MSE 4076	Senior Design Laboratory and Senior Design Laboratory [1]	
MSE 4095H & MSE 4096H	Honors Senior Design-Laboratory and Honors Senior Design Laboratory [2]	
Subtotal		21
Major Requirements		
MSE 2114	Math Programming MSE I	1
MSE 3054	Mechanical Behavior of Materials	3
MSE 3064	Mechanical Behavior of Materials Laboratory	1
MSE 3114	Mathematics Programming in Materials Science II	1
MSE 4055	Materials Selection and Design I and II	3
MSE 4644	Materials Optimization Through Designed Experiments	3
Physical Materials Courses		
MSE 3204	Fundamentals of Electronic Materials	3
MSE 3304	Physical Metallurgy	3
MSE 4414	Physical Ceramics	3
MSE 4554	Polymer Engineering	3
Subtotal		24
Additional Course Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry [3]	3
CHEM 1045	General Chemistry Laboratory	1
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
Subtotal		20
Electives		
Technical Electives		*12*
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
MSE 2884	Materials Engineering Professional Development I (1A)	1
MSE 3884	Materials Engineering Professional Development II (1A)	1
MSE 4085	Senior Capstone Recitation (1A) [1]	2
MSE 4086	Senior Capstone Recitation (1A) [1]	1
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
or ECON 2006	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (#QUANT-5F; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3

ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 should be double counted with either Pathway 2, 3 or 6a to avoid taking any additional credit hours.		
Subtotal		49
Total Credits		**126**

1 ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for MSE 4075 Senior Design Laboratory + MSE 4076 Senior Design Laboratory + MSE 4085 Senior Capstone Recitation + MSE 4086 Senior Capstone Recitation. Students will need to meet the prerequisites for MSE 4075/4085 to be eligible to take ENGE 4735/4736. These courses will also count in the in-major GPA.

2 To enroll in MSE 4095H and MSE 4096H, students must be in the Honors College and receive approval from the MSE department.

3 Students interested in focusing in the area of polymers are strongly encouraged to take CHEM 1036 General Chemistry in the first spring semester and speak with the MSE undergraduate advisor.

Technical Electives:

Twelve (12) credits are required from the lists below[1,2]. A minimum of six credits must be taken from group one and a maximum of six credits may be taken from group two. All 12 credits may be satisfied from group one. Courses must be taken for a grade (Pass/Fail not acceptable). Other courses not listed may be counted with special approval; initiate requests through the MSE Undergraduate Academic Advisor.

1 Technical elective credit may be earned in study abroad opportunities. Please see your MSE undergraduate academic advisor.

2 MSE 4974 Independent Study + MSE 4994 Undergraduate Research total credit hours limited to a maximum of six without prior approval.

Group 1: Materials Specific Courses

Must choose a minimum of six credits.

Code	Title	Credits
BIOL 2124	Cell and Molecular Biology for Engineers	2
CHEM 2154	Analytical Chemistry for Chemistry Majors	4
CHEM 2535	Organic Chemistry	3
CHEM 2536	Organic Chemistry	3
CHEM 2555	Organic Synthesis and Techniques Lab	2
CHEM 2565	Principles of Organic Chemistry	3
CHEM 3615	Physical Chemistry	3
CHEM 4534	Organic Chemistry of Polymers	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
CHEM 4634	Polymer and Surface Chemistry	3
CHEM 4994	Undergraduate Research	1-19
ECE 3054	Electrical Theory	3
ECE 3214	Semiconductor Device Fundamentals	3
ECE 3254	Industrial Electronics	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ESM 2304	Dynamics	3
ESM 4024	Advanced Mechanical Behavior of Materials	3
ESM 4044	Mechanics of Composite Materials	3
ESM 4105	Engineering Analysis of Physiologic Systems	3
GEOS 4634	Environmental Geochemistry	3
MSE 4044	Powder Processing	3
MSE 4164	Principles of Materials Corrosion	3
MSE 4234	Semiconductor Processing	3
MSE 4304	Metals and Alloys	3
MSE 4305	Physical Metallurgy and Modeling of Metal Casting	3
MSE 4306	Physical Metallurgy and Modeling of Metal Casting	3
MSE 4384	Nuclear Materials	3
MSE 4574	Biomaterials	3
MSE 4614	Nanomaterials	3
MSE 5024	Mathematical Methods in Materials Research	3
MSE 5124	Materials Optimization Through Designed Experiments	3
NANO 3015	Nanoscale Synthesis, Fabrication, and Characterization	4
NANO 3016	Nanoscale Synthesis, Fabrication, and Characterization	4
NSEG 3145	Fundamentals of Nuclear Engr	3
NSEG 3146	Fundamental of Nuclear Engr	3
PHYS 3324	Modern Physics	4
PHYS 3355	Intermediate Mechanics	3
PHYS 3405	Intermediate Electricity and Magnetism	3
PHYS 4564	Polymer Physics	3
PHYS 4574	Nanotechnology	3
PHYS 4714	Introduction to Biophysics	3
SBIO 3444	Sustainable Biomaterials and Bioenergy	3
SBIO 4444	Plant Polymers & Biocomposites	3
MSE 3000	Any non-required MSE 3000 level course	3
MSE 4000	Any non-required MSE 4000 level courses	3
MSE 5000	Any non-required MSE 5000 level course	3

Group 2: Materials Non-Specific Courses

A maximum of six credits may be taken.

Code	Title	Credits
BSE 4394	Water Supply and Sanitation in Developing Countries	3
BMES 2104	Introduction to Biomedical Engineering	3
BMES 4064	Introduction to Medical Physiology	3
CEE 3104	Introduction to Environmental Engineering	3
CEE 3604	Introduction to Transportation Engineering	3
CHE 4144	Business and Marketing Strategies for the Process Industries	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2546	Organic Chemistry Laboratory	1
CHEM 3054	Postconsumer Materials	3
CHEM 4114	Instrumental Analysis	3
CS 3824	Introduction to Computational Biology and Bioinformatics	3
ESM 3234	Fluid Mechanics I-Control Volume Analysis	3

ESM 3334	Fluid Mechanics II-Differential Analysis	3
ESM 4106	Engineering Analysis of Physiologic Systems	3
ESM 4194	Sustainable Energy Solutions for a Global Society	3
GEOS 3504	Mineralogy	3
GEOS 4234	Vertebrate Evolution	4
MATH 3214	Calculus of Several Variables	3
MATH 4234	Elementary Complex Analysis	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3
ME 3514	System Dynamics	3
ME 3524	Mechanical Vibrations	4
ME 3624	Mechanical Design	4
ME 4194	Sustainable Energy Solutions for a Global Society	3
ME 4624	Finite Element Practice in Mechanical Design	3
ME 4994	Undergraduate Research	1-19
NSEG 3604	Radiation Detection, Protection and Shielding	3
NSEG 4204	Nuclear Fuel Cycle	3
PHYS 3655	Introduction to Astrophysics	3
PHYS 3656	Introduction to Astrophysics	3
PHYS 3704	Thermal Physics	3
SBIO 3324	Green Building Systems	3
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	3
STAT 3005	Statistical Methods	3
STAT 3615	Biological Statistics	3
STAT 3704	Statistics for Engineering Applications	2
STAT 4105	Theoretical Statistics	3
STAT 4444	Applied Bayesian Statistics	3
STAT 4604	Statistical Methods for Engineers	3
STAT 4705	Probability and Statistics for Engineers	3
STAT 4706	Probability and Statistics for Engineers	3
STAT 4714	Probability and Statistics for Electrical Engineers	3

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The MSE Department fully supports this policy. Specific expectations for satisfactory progress for Materials Science and Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91
- Maintain an in-major GPA of 2.0 or better and an overall GPA of 2.0 or better
- Students may not earn a semester GPA less than 2.0 in any two consecutive semesters
- Students must complete a minimum of nine credits per semester satisfying the MSE degree requirements,
- A grade of C or better in MSE 2044 Fundamentals of Materials Engineering (or MSE 2034 Elements of Materials Engineering) is required as a prerequisite for all MSE courses, and
- Students are allowed to take MSE 2044 Fundamentals of Materials Engineering (or MSE 2034 Elements of Materials Engineering) a maximum of two times in their attempt to achieve a grade of C or better.

Graduation Requirements

To qualify for a B.S. degree in MSE, a student must:

1. Complete at least 126 credit hours
2. Earn a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is calculated using all courses taken under the MSE designator.

Acceptable Substitutions

1. ISE 2014 Engineering Economy and a one credit free elective may be substituted for ECON 2005 Principles of Economics .
2. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
3. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra , MATH 2204 Introduction to Multivariable Calculus , and MATH 2214 Introduction to Differential Equations.
4. MSE 2034 Elements of Materials Engineering and MSE 2014 Materials Engineering Transition may be substituted for MSE 2044 Fundamentals of Materials Engineering.
5. ENGE 4735 Interdisciplinary Design Capstone and ENGE 4736 Interdisciplinary Design Capstone may be substituted for MSE 4075 Senior Design Laboratory , MSE 4085 Senior Capstone Recitation , MSE 4076 Senior Design Laboratory , and MSE 4086 Senior Capstone Recitation . These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had two years of a foreign language in high school or one year at the college level (six credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
	Credits	**13**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics (w/lab)	4
	Credits	**16**
Second Year		
Fall Semester		
ESM 2104	Statics	3
ISE 2214	Manufacturing Processes Laboratory	1

MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics (w/lab)	4
MSE 2044	Fundamentals of Materials Engineering (C)	4
MSE 2884	Materials Engineering Professional Development I	1
	Credits	**16**
Spring Semester		
CHEM 1036	General Chemistry	3
ESM 2204	Mechanics of Deformable Bodies	3
MATH 2214	Introduction to Differential Equations	3
MSE 2054	Fundamentals of Materials Science	3
MSE 2114	Math Programming MSE I	1
MSE 3314	Materials Laboratory I	1
Pathways Concept 2, 3, or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECON 2005	Principles of Economics	3
MSE 3114	Mathematics Programming in Materials Science II	1
MSE 3134	Crystallography and Crystal Structures	3
MSE 4034	Thermodynamics of Materials Systems	3
MSE 4424	Materials Laboratory II	1
Physical Materials Course		3
Physical Materials Course		3
	Credits	**17**
Spring Semester		
MSE 3044	Transport Phenomena in MSE	3
MSE 3054	Mechanical Behavior of Materials	3
MSE 3064	Mechanical Behavior of Materials Laboratory	1
MSE 3884	Materials Engineering Professional Development II	1
MSE 4644	Materials Optimization Through Designed Experiments	3
Physical Materials Course		3
Technical Elective		3
	Credits	**17**
Fourth Year		
Fall Semester		
MSE 4055	Materials Selection and Design I and II	3
MSE 4075	Senior Design Laboratory	1
MSE 4085	Senior Capstone Recitation	2
Technical Elective		3
Technical Elective		3
Pathways Concept 2, 3, or 6a		3
	Credits	**15**
Spring Semester		
MSE 4076	Senior Design Laboratory	2
MSE 4086	Senior Capstone Recitation	1
Physical Materials Course		3
Technical Elective from list		3
Pathways Concept 2, 3, or 6a		3
Pathways Concept 2, 3, or 6a		3
	Credits	**15**
	Total Credits	**126**

Materials Science and Engineering Major with Nuclear Materials Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
MSE 2044	Fundamentals of Materials Engineering (C)	4
MSE 2054	Fundamentals of Materials Science	3
MSE 3044	Transport Phenomena in MSE	3
MSE 3134	Crystallography and Crystal Structures	3
MSE 3314	Materials Laboratory I	1
MSE 4034	Thermodynamics of Materials Systems	3
MSE 4424	Materials Laboratory II	1
Select one of the following:		3
MSE 4075 & MSE 4076	Senior Design Laboratory and Senior Design Laboratory [1]	
MSE 4095H & MSE 4096H	Honors Senior Design-Laboratory and Honors Senior Design Laboratory [2]	
Subtotal		21
Major Requirements		
MSE 2114	Math Programming MSE I	1
MSE 3054	Mechanical Behavior of Materials	3
MSE 3064	Mechanical Behavior of Materials Laboratory	1
MSE 3114	Mathematics Programming in Materials Science II	1
MSE 4055	Materials Selection and Design I and II	3
MSE 4644	Materials Optimization Through Designed Experiments	3
Physical Materials Courses		
MSE 3204	Fundamentals of Electronic Materials	3
MSE 3304	Physical Metallurgy	3
MSE 4414	Physical Ceramics	3
MSE 4554	Polymer Engineering	3
Subtotal		24
Option Required Courses		
MSE 4164	Principles of Materials Corrosion	3
MSE 4384	Nuclear Materials	3
NSEG 3145	Fundamentals of Nuclear Engr	3
NSEG 3146	Fundamental of Nuclear Engr	3
Subtotal		12
Additional Course Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry [3]	3
CHEM 1045	General Chemistry Laboratory	1
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
Subtotal		20
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
MSE 2884	Materials Engineering Professional Development I (1A)	1
MSE 3884	Materials Engineering Professional Development II (1A)	1
MSE 4085	Senior Capstone Recitation (1A) [1]	2
MSE 4086	Senior Capstone Recitation (1A) [1]	1
Pathways Concept 2 - Critical Thinking in the Humanities		

Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
or ECON 2006	Principles of Economics	
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 should be double counted with either Pathway 2, 3 or 6a to avoid taking any additional credit hours.		
Subtotal		49
Total Credits		**126**

[1] ENGE 4735 Interdisciplinary Design Capstone + ENGE 4736 Interdisciplinary Design Capstone may be substituted for MSE 4075 Senior Design Laboratory + MSE 4076 Senior Design Laboratory + MSE 4085 Senior Capstone Recitation + MSE 4086 Senior Capstone Recitation. Students will need to meet the prerequisites for MSE 4075/MSE 4085 to be eligible to take ENGE 4735/ENGE 4736. These courses will also count in the in-major GPA.

[2] To enroll in MSE 4095H and MSE 4096H, students must bein the Honors College and receive approval from the MSE department.

[3] Students interested in focusing in the area of polymers are strongly encouraged to take CHEM 1036 General Chemistry in the first spring semester and speak with the MSE undergraduate advisor.

1. Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The MSE Department fully supports this policy. Specific expectations for satisfactory progress for Materials Science and Engineering majors are as follows:
2. Each student must meet the minimum University-wide criteria as described in Policy 91
3. Maintain an in-major GPA of 2.0 or better and an overall GPA of 2.0 or better
4. Students may not earn a semester GPA less than 2.0 in any two consecutive semesters
5. Students must complete a minimum of nine credits per semester satisfying the MSE degree requirements,
6. A grade of C or better in MSE 2044 Fundamentals of Materials Engineering (or MSE 2034 Elements of Materials Engineering) is is required as a prerequisite for all MSE courses, and
7. Students are allowed to take MSE 2044 Fundamentals of Materials Engineering (or MSE 2034 Elements of Materials Engineering) a maximum of two times in their attempt to achieve a a grade of C or better.

Graduation Requirements

To qualify for a B.S. degree in MSE, a student must:

1. Complete at least 126 credit hours
2. Earn a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is calculated using all courses taken under the MSE designator.

Acceptable Substitutions

1. ISE 2014 Engineering Economy and a one credit free elective may be substituted for ECON 2005 Principles of Economics.
2. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
3. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra, MATH 2204 Introduction to Multivariable Calculus, and MATH 2214 Introduction to Differential Equations.
4. MSE 2034 Elements of Materials Engineering and MSE 2014 Materials Engineering Transition may be substituted for MSE 2044 Fundamentals of Materials Engineering.
5. ENGE 4735 Interdisciplinary Design Capstone and ENGE 4736 Interdisciplinary Design Capstone may be substituted for MSE 4075 Senior Design Laboratory, MSE 4085 Senior Capstone Recitation, MSE 4076 Senior Design Laboratory, and MSE 4086 Senior Capstone Recitation. These courses will also count in the in-major GPA.

Foreign Language Requirement

Students must have had two years of a foreign language in high school or one year at the college level (six credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGE 1215	Foundations of Engineering	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
	Credits	**13**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics (w/lab)	4
	Credits	**16**

Second Year		
Fall Semester		
ESM 2104	Statics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics	4
MSE 2044	Fundamentals of Materials Engineering (C)	4
MSE 2884	Materials Engineering Professional Development I	1
	Credits	**16**
Spring Semester		
CHEM 1036	General Chemistry	3
ESM 2204	Mechanics of Deformable Bodies	3
MATH 2214	Introduction to Differential Equations	3
MSE 2054	Fundamentals of Materials Science	3
MSE 2114	Math Programming MSE I	1
MSE 3314	Materials Laboratory I	1
Pathways Concept 2, 3, or 6a		3
	Credits	**17**
Third Year		
Fall Semester		
ECON 2005	Principles of Economics	3
MSE 3114	Mathematics Programming in Materials Science II	1
MSE 3134	Crystallography and Crystal Structures	3
MSE 4034	Thermodynamics of Materials Systems	3
MSE 4424	Materials Laboratory II	1
Physical Materials Course		3
Physical Materials Course		3
	Credits	**17**
Spring Semester		
MSE 3044	Transport Phenomena in MSE	3
MSE 3054	Mechanical Behavior of Materials	3
MSE 3064	Mechanical Behavior of Materials Laboratory	1
MSE 3884	Materials Engineering Professional Development II	1
MSE 4164	Principles of Materials Corrosion	3
MSE 4644	Materials Optimization Through Designed Experiments	3
Physical Materials Course		3
	Credits	**17**
Fourth Year		
Fall Semester		
MSE 4055	Materials Selection and Design I and II	3
MSE 4075	Senior Design Laboratory	1
MSE 4085	Senior Capstone Recitation	2
MSE 4384	Nuclear Materials	3
NSEG 3145	Fundamentals of Nuclear Engr	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) , Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) , Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) , or Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
	Credits	**15**
Spring Semester		
MSE 4076	Senior Design Laboratory	2
MSE 4086	Senior Capstone Recitation	1
NSEG 3146	Fundamental of Nuclear Engr	3
Physical Materials Course		3
Pathways Concept 2, 3, or 6a		3
Pathways Concept 2, 3, or 6a		3
	Credits	**15**
	Total Credits	**126**

Mechanical Engineering

Our Website (http://www.me.vt.edu)

Nature of the Profession

Mechanical engineering is the broadest of the engineering professions. Because of the breadth of the ME discipline, mechanical engineers work in a wide variety of technical areas and are employed in a range of job functions. Specialty areas within the mechanical engineering discipline include, among many others, acoustics, biomechanics, CAD, controls, energy conversion and energy management, HVAC, materials, mechanical design, mechatronics, nuclear engineering, robotics and automation, and turbomachinery. The actual job functions which mechanical engineers perform vary widely as well. ME's work in design, research and development, manufacturing, service and maintenance, as well as technical sales, in almost every industry. Many are in management and administration. Many mechanical engineering graduates go on to more advanced degrees, or continue their education in other fields, such a law or business.

Employment Opportunities

Because of the diversity and breadth of the mechanical engineering profession, ME graduates find employment in a wide variety of industries, laboratories, and consulting firms. This results in a relatively stable job market that is not dependent upon a single particular industry. The textile, petroleum, chemical, electronic, automotive, aerospace, power generation, HVAC, and manufacturing industries hire large numbers of mechanical engineering graduates and the starting salaries for ME's are very competitive with the other engineering disciplines.

Because of the wide diversity of specialties and job functions any two mechanical engineers might have significantly different day-to-day activities and responsibilities. Some may be concerned with very large engineering systems while others are working with small and even microscale devices and components; some work might call for highly analytical or mathematical approaches while other work might be more amenable to experimental or empirical approaches. Mechanical engineers may be involved in the operation of processing plants, or the design of engines, prosthetic devices, steam and gas turbines or compressors and pumps, alternative fuel devices, and many other devices and systems. At Virginia Tech there is a close association between the ME departments research and design project activities with industry. This enhances the opportunities for student interaction with industry representatives.

Accreditation, Program Educational Objectives, and Student Learning Outcomes

The Bachelor of Science in Mechanical Engineering (BSME) degree program at Virginia Tech is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Mechanical and Similarly Named Engineering Programs.

Program Educational Objectives

Within a few years after graduating from the Mechanical Engineering Department at Virginia Tech, the graduates will attain:

- Positions where they utilize fundamental technical knowledge and skills in mathematics, science, and engineering to analyze and solve problems, and apply these abilities to generate new knowledge, ideas or products in academia, industry or government.
- Practical experience and organizational skills, enabling them to interact and communicate effectively (written and/or oral) with a diverse group of stakeholders to accomplish a variety of tasks.
- Roles of increasing responsibility leading to leadership positions that benefit themselves, their employers and society.
- Skills in life-long learning (e.g. self-study, continuing education/short courses or workshops, and/or formal graduate level education), as well as skills to motivate and encourage co-workers to also pursue lifelong learning.
- Roles where they demonstrate professional and ethical responsibilities toward peers, employers, and society and follow these precepts in their daily lives.

Student Learning Outcomes

We expect our students to have the following skills, knowledge, and behaviors by the time of their graduation. We want our students to obtain:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

The Curriculum

The department is committed to providing students with an exceptional experience in both the theory and practice of mechanical engineering. In the senior capstone sequence students are required to apply classroom knowledge to complex engineering problems requiring teamwork, problem formulation, economic analysis, effective communication, and product realization. These projects are carefully selected and updated to ensure relevancy to contemporary technical issues and needs. The department encourages the involvement of students prior to their senior year and students outside the department and college in these projects. The department also encourages hands-on student involvement by providing dedicated machine and welding shops that exclusively serve the undergraduate program. The required sophomore-level Manufacturing Processes Laboratory course and certification by a professional machinist are required prior to use of either of these shops. Opportunity for professional development is provided by participation in student professional organizations, such as the American Society of Mechanical Engineers, ASME, and the American Nuclear Society, ANS. In addition to the *Mechanical Engineering* major, there are majors in *Automotive Engineering* and *Robotics and Mechatronics* which offer additional specialization in those areas while still leading to the BS in Mechanical Engineering degree.

The ME curriculum provides a strong foundation in the basic physical and chemical sciences and in mathematics. These are followed by courses that provide a background in thermodynamics, numerical methods, solid and fluid mechanics, manufacturing processes, machine design, vibrations, heat and mass transfer, controls, statistics and materials. Courses in English and in the humanities and social sciences are included to broaden the individual. This background is strengthened and unified through a sequence of engineering design courses. Instructional laboratories in the junior year provide opportunities for students to learn measurement and instrumentation techniques. Students apply these skills to the acquisition and analysis of data from various engineering systems.

In all professional endeavors the mechanical engineer must consider ecological effects as well as the economic and social needs of people. The mechanical engineer must consider the conservation of natural resources and the environmental impact in the design of systems. These considerations are included in a number of ME courses and technical elective classes. Students wishing to further strengthen this area may wish to consider the Green Engineering Option at www.eng.vt.edu/green/index.php (http://www.eng.vt.edu/green/).

The unifying activity in all aspects of mechanical engineering is the design function. A special emphasis has been placed on the use of computer-aided design methods and applied design project experience as a required part of the curriculum. Elective courses in the junior and senior years provide students with the opportunity to pursue specialized interests related to career plans or preparation for graduate study.

The department participates in the Cooperative Education Program in which qualified students may alternate semesters of study with semesters of professional employment. Approximately twenty percent of all mechanical engineering students participate in this program.

The department offers graduate programs leading to the M.S., M.Eng., and Ph.D. in mechanical engineering (see the Graduate Catalog (https://catalog.vt.edu/graduate/)).

The Department of Mechanical Engineering actively seeks input on the nature and quality of our program from all interested individuals and organizations, including students, employers and supporting agencies. Our goal is to provide the best possible service to the students who entrust their education to us. Through our continuous improvement efforts, we pledge to continually improve the content of our curriculum, our educational methods and our facilities. Comments to the department head or any member of the faculty are welcomed. Note that because of this continuous improvement process entrance and degree requirements and course content are subject to change. Please consult the department academic advisor for current information.

- Automotive Engineering Major (p. 923)
- Mechanical Engineering Major (p. 925)
- Robotics and Mechatronics Major (p. 931)

Head: B. Lattimer
William S. Cross Professor: D. K. Tafti
Nicholas & Rebecca Des Champs Professor: B. Lattimer
George R. Goodson Professor: R. Pitchumani

Lewis A. Hester Professor: R. L. Mahajan
Robert E. Hord, Jr. Professor: A. Haghighat
Robert E. Hord Jr. Professor: C. Sandu
Robert E. Hord Jr. Professor: M. von Spakovsky
Samuel P. Langley Professor: C.R. Fuller
Chris C. Kraft Professor of Engineering: W. F. Ng
Clifton C. Garvin Professor: R.C. Batra
J. Bernard Jones Professor: M. Ahmadian
John R. Jones III Fellow: M. Bartlett
John R. Jones III Fellow: B. Behkam
John R. Jones III Fellow: J. Boreyko
John R. Jones III Fellow: R. Qiao
Mary V. Jones Fellow: S. Shahab
Raymond E. and Shirley B. Lynn Professor: R. Mueller
Rolls Royce Professor: C. Son
L. S. Randolph Professor: C.B. Williams
University Distinguished Professor: R.C. Batra
Adhesive and Sealant Science Professor: D.A. Dillard
Professors: M. Ahmadian, R.C. Batra, B. Behkam, P. Ben-Tzvi, L. Collins, R. De Vita, D.A. Dillard, C.R. Fuller, A. Haghighat, K.B. Kochersberger, A.J. Kurdila, B. Lattimer, R.L. Mahajan, R. Mueller, A.S. Nain, W.F. Ng, M.R. Paul, R. Pitchumani, R. Qiao, B. Raeymaekers, C. Sandu, J.J. Socha, C. Son, M.A. Stremler, D.K. Tafti, S. Taheri, M.R. von Spakovsky, C.B. Williams, and J. Zhang
Associate Professors: P. Acar, K.H. Akbari, A. Asbeck, O. Barry, M. Bartlett, J.H. Bohn, J. Boreyko, J. Cheng, M.W. Ellis, J.B. Ferris, W. Hardy, C. Hin, S. Huxtable, M.E.F. Kasarda, S. Li, Z. Li, Y. Liu, S. Shahab, S.C. Southward, A.E. Staples, A. Untaroiu, R.L. West, and A.L. Wicks
Assistant Professors: S. Kale, E. Komendera, D. Losey, J. Meadows, N. Naughton, and Z. Tian
Professor of Practice: J. Sole
Associate Professor of Practice: L. Vick
Collegiate Associate Professor: D. Freeman, D. Gonzales, J.K. Lord, M. Nowinski, and J. Warfford
Professors Emeritus: L.J. Arp, R.A. Comparin, T. Diller, N.S. Eiss, R.E. Hedgepeth, C.J. Hurst, , R.G. Leonard, J. R. Mahan, L.D. Mitchell, R. Mitchiner, D.J. Nelson, T.F. Parkinson, F.J. Pierce, J.R. Thomas, W.C. Thomas, and R.J. Whitelaw
Adjunct Professors: R. Anderl (TU Darmstadt), P.G. Brolinson (Edward Via College of Osteopathic Medicine), D. Carlson (Lord Corp.), A. Eskandarian (VCU), J. Funk (Biodynamic Research Corp.), M.J. Hampe (TU Darmstadt), T. Kress (BEST Engineering), A. Leonessa (NSF), D. Rabe (Air Force Research Lab), and B. Sanders (Air Force Research Lab)
Advanced Instructors: B. Aidi, J. Bolton, C. Galitz, S. Davison, S. Tahmasian
Instructors: J. Barbish, T.S. Chang, R. Clark, H. Pendar, J. Rule

Undergraduate Course Descriptions (ESM)

ESM 2014 - Professnl Dvlpmnt Seminar ESM (1 credit)
Topics designed to foster the professional development of the ESM student. ESM program objectives and outcomes. Professional careers, employment opportunities, expectations to the profession. Technical concentration within the ESM major. Ethical decision-making, safe and life-long learning.
Instructional Contact Hours: (1 Lec, 1 Crd)

ESM 2104 - Statics (3 credits)
Vector mechanics of forces and moments, free-body diagrams, couples, resultants, equilibrium of particles and rigid bodies in two and three dimensions, forces in trusses, frames, and machines, centroids, centers of mass, distributed forces, internal shear forces and bending moments in beams, shear and moment diagrams, friction, belt friction, area of moments of inertia, parallel axis theorem. Course requirements may be satisfied by taking MATH prerequisite prior to or concurrent with course.
Prerequisite(s): MATH 1226
Corequisite(s): MATH 2204 or MATH 2204H or MATH 2406H
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2114 - Statics & Structures (3 credits)
Vector algebra of forces, movements, couples and resultants. Free-body diagrams. Equilibrium of particles and rigid bodies in two and three dimensions. Friction. Forces in trusses and frames. Centroids, centers of mass, area moments of inertia. Internal axial forces, shear forces, and bending moments in bars in beams. Shear and moment diagrams. Stress and strain in bars in beams.
Corequisite(s): MATH 2204 or MATH 2204H or MATH 2406H.
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2204 - Mechanics of Deformable Bodies (3 credits)
Concepts of stress, strain, and deformation. Factor of safety. Stress-strain relationships and material properties. Stress concentrations. Area moments of inertia. Axially loaded members, torsionally loaded members, bending of beams. Shear and moment diagrams. Stresses due to combined loading. Thin-walled pressure vessels. Transformation of stress including Mohrs circle. Beam deflections and buckling stability.
Prerequisite(s): (ESM 2104 or ESM 2114) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2304 - Dynamics (3 credits)
Vector treatment of the kinematics and kinetics of particles and rigid bodies, Newtons laws, work and energy, impulse and momentum, impact, mass moments of inertia, rotating axes.
Prerequisite(s): (ESM 2104 or ESM 2114) and (MATH 2204 or MATH 2204H or MATH 2406H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 3024 - Introduction to Fluid Mechanics (3 credits)
Fluid properties. Hydrostatics. Derivation and application of the mass, momentum, and energy conservation equations. Dimensional analysis and similitude. Introduction to analyses of pipe flows and piping systems, open channel flows, and fluid forces on solid bodies.
Prerequisite(s): PHYS 2305 and ESM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3034 - Fluid Mechanics Laboratory (1 credit)
Introduction to experimental fluid mechanics. Dimensional analysis. Experiments on fluid properties, flow measurements, and flow visualization, including manometry, determining hydrostatic forces on submerged surfaces, applications of the impulse-momentum principle, velocity measurements, measuring drag forces, quantifying flow in channels. Modern data acquisition techniques.
Prerequisite(s): ESM 2304 and ECE 3054
Corequisite(s): ESM 3234
Instructional Contact Hours: (3 Lab, 1 Crd)

ESM 3054 - Mechanical Behavior of Materials (3 credits)
Mechanical properties and behavior of solid materials subjected to static, cyclic, and sustained loads resulting from stress states, environments, and stress histories typical of service conditions; multiaxial failure criteria; behavior of cracked bodies; fatigue of materials; creep of materials; microstructure-property relationships; design methodologies.
Prerequisite(s): ESM 2204 and (MSE 2034 or MSE 2044 or MSE 3094 or AOE 3094 or CEE 3684)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MSE 3054

ESM 3064 - Mechanical Behavior of Materials Laboratory (1 credit)
Laboratory experiments on behavior and mechanical properties of solid materials. Tension, compression, bending, hardness, nano-indentation, and impact tests; behavior of cracked bodies; fatigue and crack growth tests; creep deformation; microstructure-property relationships; laboratory equipment, instrumentation, and computers.
Prerequisite(s): ESM 2204
Corequisite(s): ESM 3054
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: MSE 3064

ESM 3114 - Problem Definition and Scoping in Engineering Design (1 credit)
Define open-ended engineering design projects, identify relevant broad social, global, economic, cultural and technical needs and constraints, determine ways in which technical skills contribute to addressing complex engineering design challenges. Identify a capstone project for ESM 4015-4016. Pre-requisite: Junior standing in ESM.
Prerequisite(s): ESM 2014
Instructional Contact Hours: (2 Lab, 1 Crd)

ESM 3124 - Dynamics II- Analytical and 3-D Motion (3 credits)
Review of Newtons Laws, introduction to Lagranges equations, rotating coordinate systems, particle dynamics, systems of particles, rigid-body dynamics, small amplitude oscillations, holonomic and nonholonomic constraints, phase space and energy methods.
Prerequisite(s): ESM 2304 and (MATH 2214 or MATH 2214H or MATH 2406H) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3134 - Dynamics III - Vibration and Control (3 credits)
Single-degree-of-freedom vibration, n-degree-of-freedom systems, continuous systems, nonlinear systems, system stability, introduction to the feedback control of dynamic systems.
Prerequisite(s): ESM 3124 and MATH 4564
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3154 - Solid Mechanics (3 credits)
Introduction to tensors, mathematical description of deformations and internal forces in solids, equations of equilibrium, principle of virtual work, linear elastic material behavior, solution for linear elastic problems including axially and spherically symmetric solutions, stress function solutions to plane stress and strain problems, solutions to 3-D problems, energy methods.
Prerequisite(s): ESM 2204 and (MATH 2214 or MATH 2214H)
Corequisite(s): MATH 4574
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3234 - Fluid Mechanics I-Control Volume Analysis (3 credits)
Fluid statics. Control volume approach to flow analysis: conservation laws, pipe flows, compressible flow, open channel flow.
Prerequisite(s): ESM 2304 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3334 - Fluid Mechanics II-Differential Analysis (3 credits)
Introduction to continuum mechanics for fluid systems. Fluid kinematics. Differential approach to flow analysis: conservation equations, exact solutions, potential flows, viscous flows.
Prerequisite(s): ESM 3234 or ME 3404
Corequisite(s): MATH 4574
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 3444 - Mechanics Laboratory (2 credits)
Concepts in instrumentation, data acquisition, and signal analysis. Measurements of mechanics quantities and phenomena associated with solid, fluid, and dynamical systems. Open-ended problem definition and approach formulation. Application and synthesis of engineering mechanics fundamentals to the modeling and solution of open-ended problems. Group-working skills and effective written and oral communication.
Prerequisite(s): ESM 3234 and ESM 3034 and ESM 3054 and ESM 3064 and ESM 3124 and ECE 3054
Corequisite(s): ESM 3134, ESM 3154, ESM 3334
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

ESM 3704 - Basic Principles of Structures (3 credits)
Static equilibrium of forces and moments, concurrent and nonconcurrent force systems, center of gravity, concentrated and distributed loads. Solution of trusses. Stress and strain, elastic behavior of materials, cables and arches, shear, bending, and deformation in beams, indeterminate structures. Not available to students in engineering.
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4014 - Applied Fluid Mechanics (3 credits)
Analysis of flow over practical configurations, panel methods, Reynolds-averaged Navier-Stokes equations, turbulent boundary layers, flow separation and three-dimensional effects. Unsteady flows, fluid-structure interactions.
Prerequisite(s): ESM 2074 and ESM 3016
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4015 - Creative Design and Project (3 credits)
Capstone senior design project. Synthesis and application of fundamental principles of engineering science and mechanics to an open-ended problem. 4015: Project proposal, including objectives, goals and plans for project. Identification of needs, constraints, and engineering standards with consideration of public health, safety, and welfare, including ethical, global, cultural, societal, environmental, and economic contexts. Proof-of-concept prototyping. Teamwork and communication of design and project progress. 4016: Design specifications with consideration of public health, safety, and welfare, as well as ethical, global, cultural, social, environmental, and economic factors where applicable. Design, test, and analysis of functional prototype. Teamwork and communication of design and project progress. Pre: Senior standing.
Prerequisite(s): ESM 3114
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4016 - Creative Design and Project (3 credits)
Capstone senior design project. Synthesis and application of fundamental principles of engineering science and mechanics to an open-ended problem. 4015: Project proposal, including objectives, goals and plans for project. Identification of needs, constraints, and engineering standards with consideration of public health, safety, and welfare, including ethical, global, cultural, societal, environmental, and economic contexts. Proof-of-concept prototyping. Teamwork and communication of design and project progress. 4016: Design specifications with consideration of public health, safety, and welfare, as well as ethical, global, cultural, social, environmental, and economic factors where applicable. Design, test, and analysis of functional prototype. Teamwork and communication of design and project progress. Pre: Senior standing.
Prerequisite(s): ESM 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4024 - Advanced Mechanical Behavior of Materials (3 credits)
Mechanical behavior of materials, emphasizing solid mechanics aspects and methods for predicting strength and life of engineering components. Plasticity, failure criteria, fracture mechanics, crack growth, strain-based fatigue, and creep. Microstructure-property relationships, and laboratory demonstrations.
Prerequisite(s): ESM 3054 or MSE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4044 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design.
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4610

ESM 4084 - Engineering Design Optimization (3 credits)
Use of mathematical programming methods for engineering design optimization including linear programming, penalty function methods, and gradient projection methods. Applications to minimum weight design, open-loop optimum control, machine design, and appropriate design problems from other engineering disciplines.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4084

ESM 4105 - Engineering Analysis of Physiologic Systems (3 credits)
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses.
Prerequisite(s): ESM 2304 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4106 - Engineering Analysis of Physiologic Systems (3 credits)
Engineering analysis of human physiology. Physiologic systems are treated as engineering systems with emphasis input-output considerations, system interrelationships and engineering analogs. 4105 - Mass and electrolyte transfer, nerves, muscles, renal system. 4106 - cardiovascular mechanics, respiratory system, digestive systems, senses.
Corequisite(s): ME 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4114 - Nonlinear Dynamics and Chaos (3 credits)
Motion of systems governed by differential equations: stability, geometry, phase planes, bifurcations, Poincare sections, point attractors, limit cycles, chaos and strange attractors, Lyapunov exponents. Forced, nonlinear oscillations: jump phenomena, harmonic resonances, Hopf bifurcations, averaging and multiple-scales analysis. Systems governed by discrete maps: return maps, cobweb plots, period-multiplying bifurcations, intermittency, delay coordinates, fractal dimensions.
Prerequisite(s): (ESM 2304 or PHYS 2504) and (MATH 2214 or MATH 2214H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4514

ESM 4154 - Nondestructive Evaluation of Materials (3 credits)
Concepts and methods of nondestructive evaluation of materials. Discussion of techniques and mathematical bases for methods involving mechanical, optical, thermal, and electromagnetic phenomena; design for inspectability; technique selection criteria; information processing and handling; materials response measurement and modeling; signal analysis.
Prerequisite(s): ESM 3054 and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4194 - Sustainable Energy Solutions for a Global Society (3 credits)
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764.
Prerequisite(s): (CHEM 1035 or CHEM 1055) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ME 4194

ESM 4204 - Musculoskeletal Biomechanics (3 credits)
Skeletal anatomy and mechanics. Muscle anatomy and mechanics. Theory and application of electromyography. Motion and force measuring equipment and techniques. Inverse dynamics modeling of the human body. Current topics in musculoskeletal biomechanics research.
Prerequisite(s): ESM 2304 and (CS 1044 or CS 1064 or CS 1114 or AOE 2074 or ESM 2074 or ME 2004)
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4224 - Biodynamics and Control (3 credits)
Study of human movement dynamics and neuromuscular control of multi-degree-of-freedom systems. Computational simulation of forward-dynamics and state-space linear control of human movement to investigate functional performance and neuromuscular pathology.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4234 - Mechanics of Biological Systems (3 credits)
Anatomy and physiology of biological systems such as cells, tissues, and organs. Experimental techniques for determining the mechanical behavior of biological systems. Simplified mechanics-based mathematical models of biological systems. Specific biological systems include cells, tissues, and organs of the musculoskeletal, cardiovascular, integumentary system, and reproductive systems.
Prerequisite(s): ESM 2204 and MATH 2214 and MATH 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4234

ESM 4245 - Mechanics of Animal Locomotion (3 credits)
4245: Mechanical and biological principles of terrestrial animal locomotion, including walking, running, jumping, climbing, burrowing, and crawling. Terrestrial locomotion- based bio-inspired design. 4246: Mechanical and biological principles of animal locomotion in fluids, including active and gliding flight, swimming, jetting, and running on water. Engineering design inspired by fluid based biological locomotion.
Prerequisite(s): ESM 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4246 - Mechanics of Animal Locomotion (3 credits)
Mechanical and biological principles of of animal locomotion in fluids, including active and gliding flight, swimming, jetting, and running on water. Enginneering desgn inspired by fluid-based biological locomotion.
Corequisite(s): ESM 3024 or ESM 3234 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4304 - Hemodynamics (3 credits)
Study of the human cardiovascular system and blood flow. Anatomy and physiology of the human heart, vascular system, and its organization. Blood physiology and rheology. Non-Newtonian blood flow models. Steady and pulsatile blood flow in rigid and elastic arteries. Pressure waves in elastic arteries. Three-dimensional blood flow in the aortic arch and flow around heart valves.
Prerequisite(s): ESM 3334 or ME 3404 or ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ESM 4404 - Fundamentals of Professional Engineering (2 credits)
A refresher of basic principles and problem solving techniques involving twelve subject areas most common to all engineering curricula. The topics include those tested by the National Council of Engineering Examiners on the EIT (Engineer in Training) examination, the first requirement, in all fifty states, toward P.E. (Professional Engineer) licensing. Duplicates material of other engineering courses and impracticable for non-engineers, hence not usable for credit toward any degree. Pre: Junior and senior standing in Engineering or in Building Construction or Graduate students in Engineering.
Instructional Contact Hours: (2 Lec, 2 Crd)

ESM 4444 - Stability of Structures (3 credits)
Introduction to the methods of static structural stability analysis and their applications. Buckling of columns and frames. Energy method and approximate solutions. Elastic and inelastic behavior. Torsional and lateral buckling. Use of stability as a structural design criterion.
Prerequisite(s): AOE 3024 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4054

ESM 4614 - Probability-Based Modeling, Analysis, and Assessment (3 credits)
Uncertainty analysis of engineering data, parameters estimation, probability concepts, random variables, functions of random variables, probability-based performance functions and failure modes, risk and reliability functions, probability of failure and safety index, random sequences and stochastic processes, correlation functions and spectral densities, return period and extreme values, failure rates, performance monitoring and service life prediction.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 4614

ESM 4734 - An Introduction to the Finite Element Method (3 credits)
The finite element method is introduced as a numerical method of solving the ordinary and partial differential equations arising in fluid flow, heat transfer, and solid and structural mechanics. The classes of problems considered include those described by the second-order and fourth-order ordinary differential equations and second-order partial differential equations. Both theory and applications of the method to problems in various fields of engineering and applied sciences will be studied.
Prerequisite(s): (CS 3414 or MATH 3414 or AOE 2074 or ESM 2074) and (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4024

ESM 4904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ESM 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (ME)

ME 2004 - Engineering Analysis Using Numerical Methods (3 credits)
Numerical methods applied to engineering analysis with a design/lab studio. Numerical techniques including root finding, linear algebra, integration, ordinary differential equations, curve fitting, discrete Fourier transforms, optimization. Structured programming and iterative problem-solving using a high-level environment such as Matlab. Design/Lab Studio.
Prerequisite(s): (ENGE 1215 or ENGE 1414) and MATH 1226 and (MATH 2114 or MATH 2114H or MATH 2405H or MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ME 2024 - Introduction to Engineering Design and Economics (3 credits)
Design process, mini-design projects, collaborative design, product dissection, economics of decision making, reverse engineering, intellectual property, oral, written, and graphic communications, engineering ethics.
Prerequisite(s): ENGE 1216 or ENGE 1114 or ENGE 1434 or ENGE 1414
Corequisite(s): ESM 2104, MATH 2114, PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 2124 - Introduction to Thermal and Fluid Engineering (2 credits)
Basics of thermodynamics, fluid mechanics, and heat transfer. Fluid and thermal properties of materials. Ideal gas equation of state. First law of thermodynamics in closed systems. Transient heat transfer. First law of thermodynamics in open systems. Fluid mechanics balances, open systems. Emphasis on applications in all topic areas.
Prerequisite(s): (ESM 2104 or PHYS 2306) and (MATH 2114 or MATH 2114H)
Corequisite(s): MATH 2214
Instructional Contact Hours: (2 Lec, 2 Crd)

ME 2134 - Thermodynamics (4 credits)
Classical (equilibrium) thermodynamics and its applications. Includes thermodynamic properties of pure substances: property diagrams, property tables, property software, equations of state; the first law of thermodynamics; the second law of thermodynamics; gas mixtures; combustion: atomic and energy balances; and power and refrigeration cycles.
Prerequisite(s): PHYS 2305 and (MATH 2204 or MATH 2204H or MATH 2406H) and CHEM 1035
Corequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H).
Instructional Contact Hours: (4 Lec, 4 Crd)

ME 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 3024 - Engineering Design and Economics (3 credits)
Engineering design process; project management; product planning; customer needs, specifications, and Quality Function Deployment (QFD); benchmarking and intellectual property; concept generation, screening, scoring, and selection; design for assembly, product architecture, economic, and ethical considerations; concept testing. Written and oral communications of engineering design; computer aided design. Team-based term project with prototype fabrication of mechanical assembly manipulated by a microcontroller. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ESM 2104 and ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3034 - Mechanical Engineering Discourse (1 credit)
Principles and application of effective technical and professional communication in mechanical engineering; organizing, structuring, and developing effective written documents and oral presentations for a range of audiences, including technical reports, memorandums, laboratory reports, live and recorded presentations, and posters for public exhibition; use of effective language and style; development of effective visual aids; presentation delivery skills; acquiring new knowledge using appropriate learning strategies by finding, comprehending and evaluating information from a variety of sources; ethical and professional responsibilities in both identifying appropriate information and communicating technical results. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ENGL 1106
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)

ME 3124 - Thermodynamics (3 credits)
Classical thermodynamics and its applications. Thermodynamic properties of pure substances: property tables, property software, equations of state. First law of thermodynamics. Second law of thermodynamics. Gas mixtures. Combustion: atom and energy balances. Power and refrigeration cycles.
Prerequisite(s): (ME 2124 and MATH 2214 and MATH 2204) or (ME 2124 and MATH 2214 and MATH 2204H) or (ME 2124 and MATH 2214 and MATH 2224) or (ME 2124 and MATH 2214 and MATH 2224H) or (ME 2124 and MATH 2214H and MATH 2204) or (ME 2124 and MATH 2214H and MATH 2204H) or (ME 2124 and MATH 2214H and MATH 2224) or (ME 2124 and MATH 2214H and MATH 2224H) or (ME 2124 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3134 - Fundamentals of Thermodynamics (3 credits)
Fundamental concepts, first and second laws, gas and vapor processes with emphasis on chemical reactions, statistical interpretation of entropy, limited use of thermodynamic property tables. This course is for non-ME students.
Prerequisite(s): MATH 2214 or MATH 2214H
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3194 - Technology, Innovation and Humanistic Engineering for a Sustainable Future (3 credits)
Foundational understanding of converging, emerging and disruptive technologies. Pedagogical aspects of innovation, team dynamics and effective communication. Leadership Cube—Six principles of effective leadership. Humanistic engineering. Sustainable energy and sustainable water platforms. Smart device designs for disease diagnostics and mitigation. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3304 - Heat and Mass Transfer (3 credits)
Comprehensive basic course in heat and mass transfer for mechanical engineering students. Principles of conduction, convection, and radiation with applications to heat exchangers and other engineering systems.
Prerequisite(s): ME 2134 and ME 3414 and (MATH 2214 or MATH 2214H or MATH 2306H) and (MATH 2204 or MATH 2204H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3404 - Fluid Mechanics (3 credits)
Comprehensive first course in basic and applied fluid mechanics. Fluid properties, statics, kinematics, and dynamics. Eulers and Bernoullis equations. Hydrodynamics. Dimensional analysis and similitude. Real fluids, laminar and turbulent flows. Boundary layer model and approximate analysis. Compressible flow and propulsion devices. Flow measurement. Introduction to turbomachinery with applications.
Prerequisite(s): (ME 2124 and MATH 2214 and MATH 2204) or (ME 2124 and MATH 2214 and MATH 2204H) or (ME 2124 and MATH 2214 and MATH 2224) or (ME 2124 and MATH 2214 and MATH 2224H) or (ME 2124 and MATH 2214H and MATH 2204) or (ME 2124 and MATH 2214H and MATH 2204H) or (ME 2124 and MATH 2214H and MATH 2224) or (ME 2124 and MATH 2214H and MATH 2224H) or (ME 2124 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ME 3414 - Fluid Dynamics (4 credits)
Comprehensive first course in fluid dynamics. Fluid properties. Hydrostatics. Mass, momentum,and energy conservation in control volumes. Elementary dynamics and Bernoullis equation.Dimensional analysis and similitude. Laminar and turbulent flows. Introduction to Eulers and Navier-Stokes equations. Pipe flows. External flows and boundary layers. Introduction to compressible flows. Includes laboratory experiments.
Prerequisite(s): ME 2004 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2204 or MATH 2204H or MATH 2406H) and (MATH 2214 or MATH 2214H or MATH 2406H)
Corequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3504 - Dynamic Systems - Vibrations (3 credits)
Principles of dynamic system modeling with emphasis on second order mechanical systems. Harmonic and nonharmonic vibrations of single and multi-degree of freedom systems. Applications of computer simulation and analysis techniques in vibrations.
Prerequisite(s): (ME 3514 and MATH 2214) or (ME 3514 and MATH 2214H) or (ME 3514 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3514 - System Dynamics (3 credits)
Mathematical descriptions of physical systems behavior including mechanical, electrical, thermal, and fluid systems and their combinations; system descriptions using state variable and transfer functions; analysis of system responses: convolution integral, frequency response, numerical simulations, and Laplace transform methods; systems concepts: input-output, causality, and analogies; general process descriptions including first-order, second-order, and time delayed.
Prerequisite(s): (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2204H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214 and MATH 2224H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2204H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224 and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2114) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2114H) or (ESM 2104 and ESM 2304 and MATH 2214H and MATH 2224H and MATH 2405H) or (ESM 2104 and ESM 2304 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3524 - Mechanical Vibrations (4 credits)
Development and application of mathematical methods, physical understanding, and computational tools for modeling, analysis, and design of vibrating systems. Free and forced vibration of single and multiple degree-of-freedom systems, particularly systems experiencing sinusoidal excitation. Distributed parameter systems. Practical engineering applications.
Prerequisite(s): ESM 2304 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2214 or MATH 2214H or MATH 2406H) and ME 2004
Instructional Contact Hours: (4 Lec, 4 Crd)

ME 3534 - Controls Engineering I (4 credits)
Fundamentals of feedback control theory, time-domain and frequency-domain analysis, automatic control system design synthesis to meet performance and stability requirements, numerical simulation and discrete real-time implementation on microcontrollers.
Prerequisite(s): ME 2004 and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2214 or MATH 2214H or MATH 2406H) and (MATH 2204 or MATH 2204H or MATH 2406H) and ESM 2104 and ESM 2304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3604 - Kinematics and Dynamics of Machinery (3 credits)
Kinematic analysis and design of cams, gears, and linkages, velocity, acceleration and force analysis, kinematic synthesis, balancing, kinematic and force analysis by complex numbers, computer-aided analysis, and synthesis of linkages.
Prerequisite(s): ESM 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3614 - Mechanical Design I (3 credits)
Design of mechanical components subject to static and fatigue loads. Design using screws, fasteners, springs and bearings. Computer-aided design using transfer matrix and finite element methods.
Prerequisite(s): ESM 2204 and (MATH 2214 or MATH 2214H) and (MATH 2114 or MATH 2114H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 3624 - Mechanical Design (4 credits)
Comprehensive first course in mechanical design. Stress and Strain. Fundamentals of designing mechanical components subjected to static and cyclical loads. Design elements for screws, fasteners, springs, and welds. Hands-on laboratory learning of concepts discussed in class. Course credit will not be awarded for both ME 3614 and ME 3624.
Prerequisite(s): ME 2004 and ESM 2204 and (MATH 2214 or MATH 2214H or MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

ME 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4005 - Mechanical Engineering Lab (3 credits)
Principles of measurement, measurement standards and accuracy, detectors and transducers, digital data acquisition principles, signal conditioning systems and readout devices statistical concepts in measurement, experimental investigation of engineering systems, technical report writing.
Prerequisite(s): (STAT 3704 or STAT 4604 or STAT 4705 or STAT 4714) and ME 3524 and ECE 2054
Corequisite(s): ME 3534
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4006 - Mechanical Engineering Lab (3 credits)
Principles of measurement, measurement standards and accuracy, detectors and transducers, digital data acquisition principles, signal conditioning systems and readout devices statistical concepts in measurement, experimental investigation of engineering systems, technical report writing.
Prerequisite(s): ME 4005 and ECE 3254
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4015 - Engineering Design and Project (3 credits)
Team oriented, open-ended, multi-disciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product realization and testing. Emphasis on documenting and reporting technical work. Making informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. 4015: Problem identification, including consideration of public health and welfare, as well as global, cultural, social, environmental, and economic factors and constraints; idea generation and concept selection; application of design, test, and analysis tools developed in previous courses; ethical and professional responsibilities; verification and validation; communication and working in teams. 4016: Project management; working on teams, analysis and optimization, fabrication and testing, and communicating technical ideas. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ME 3024 and ME 3034 and ME 3524 and ME 3534 and ME 3624 and ME 4005 and (ME 3304 or MSE 2034) and ME 3414
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4016 - Engineering Design and Project (3 credits)
Team oriented, open-ended, multi-disciplinary design projects focused on industrially relevant problems. A specific, complex engineering design problem taken from problem definition to product realization and testing. Emphasis on documenting and reporting technical work. Making informed judgments which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts. 4015: Problem identification, including consideration of public health and welfare, as well as global, cultural, social, environmental, and economic factors and constraints; idea generation and concept selection; application of design, test, and analysis tools developed in previous courses; ethical and professional responsibilities; verification and validation; communication and working in teams. 4016: Project management; working on teams, analysis and optimization, fabrication and testing, and communicating technical ideas. For Pathways Advanced Discourse credit, must complete combination of ME 3024, ME 3034, and ME 4015-4016.
Prerequisite(s): ME 4015
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4034 - Bio-Inspired Technology (3 credits)
Introduction to engineering solutions inspired by biological systems. Overview over the approach of bio-inspired technology and the state of the art. Exploration of the relationship between engineered and natural biological systems. Explanation of concepts of biological systems, such as evolutionary optimization, sensing, actuation, control, system integration, assembly and materials in engineering terms. Practice of interdisciplinary analysis skills in technical report writing projects where man-made and biological systems are evaluated for parallels to engineering and their technological potential.
Prerequisite(s): (PHYS 2205 and PHYS 2206) or (PHYS 2305 and PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4124 - Computer Aided Design of Fluid-Thermal Systems (3 credits)
Review of physical laws and engineering concepts introduced in thermodynamics, fluid mechanics, and heat transfer with applications. Emphasis on analysis, modeling, and design of engineering systems, components, and physical phenomena with state-of-the-art computer software such as Ansys CFX, Star CCM, Aspen Plus, and ProSimPlus.
Prerequisite(s): (ME 3124 or ME 2134) and (ME 3404 or ME 3414) and ME 3304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

ME 4154 - Industrial Energy Systems (3 credits)
Survey of energy-intensive technologies used in typical industrial plants, with emphasis on cost-effective energy conservation. Burners, boilers, pumps, air compressors, electric motors, lights, refrigeration plants, HVAC systems, cogeneration systems, waste heat recovery equipment. Energy-efficient design and operation. Determination of energy efficiency based on field measurements. Economic analysis of energy conservation measures. Mitigation of environmental impacts.
Prerequisite(s): ME 2134 or CHE 2164 or BSE 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4164 - Energy Systems for Buildings (3 credits)
Application of the fundamental principles of thermodynamics, heat transfer, and fluid flow to analyze energy use for building environmental control. Exploration of approaches for configuring basic thermal-fluid engineering components (e.g. pumps, piping, fans, heat exchangers, refrigeration cycles, etc.) to yield systems that provide heating, cooling, and ventilation. Introduction to techniques and software tools for estimating energy use by these systems and the associated economic and environment impact. Examination of alternate technologies for meeting building energy needs including small scale combined heat and power systems and renewable energy systems.
Prerequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4174 - Spacecraft Propulsion (3 credits)
Spacecraft propulsion systems and their applications in orbital, interplanetary, and interstellar flight. Rocket propulsion fundamentals; advanced mission analysis; physics and engineering of chemical rockets, electrical thrusters, and propellantless systems (tethers and sails); spacecraft integration issues.
Prerequisite(s): AOE 3164 or AOE 4234 or ME 4234
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4174

ME 4184 - Drone Technology and Flight Operations (3 credits)
Basic aviation science, skills training in uncrewed flight operations, and knowledge of the regulatory environment that governs drone flight. Aerodynamics, propulsion, aircraft performance, sensing and control, meteorology, the Federal Aviation Regulations, safety and risk management. Flight management tools for conducting preflight inspections and approving flight missions. Pre: Students in Mechanical Engineering will be given preference, other programs and students eligible with permission.
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

ME 4194 - Sustainable Energy Solutions for a Global Society (3 credits)
Addresses energy metrics, global and US energy supply and demand, transitional energy sources (natural gas, petroleum, coal, nuclear), sustainable/renewable source (solar, geothermal, hydro, tidal, wind, biofuels), and methods for increasing efficiencies (energy storage, batteries, green building, conservation). Options for transportation, electricity, lighting and heating needs of industry, agriculture, community, and citizens. Production, transmission, storage, and disposal issues considered in the context of global political, economic, and environmental impacts. Senior Standing in major may be substituted for pre-requisite ENGL 3764.
Prerequisite(s): (CHEM 1035 or CHEM 1055) and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4194

ME 4204 - Internal Combustion Engines (3 credits)
Analysis and design of gasoline and diesel engines. Fundamental processes and their application in current technology. Thermodynamics: air standard and air-fuel cycles. Combustion: stoichiometry, fuels, chemical equilibrium, chemical kinetics, flame propagation, knock, pollutant formation and control. Flow processes: volumetric efficiency, intake and exhaust tuning, two-stroke scavenging, carburetion, fuel injection, super- and turbo-charging.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4224 - Gas Turbines for Power and Propulsion (3 credits)
Introduction to various applications of gas turbines for land, sea and air. Aero-thermo-mechanical aspects of component performance and reliability. Operational characteristics, limitations and component matching. Industrial standards, development and certification requirements. Design of gas turbine engines and comparison of the predicted performance (specific fuel consumption) against the in-service operation.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4234 - Aerospace Propulsion Systems (3 credits)
Design principles and performance analysis of atmospheric and space propulsion engines and systems. Application of thermodynamics, compressible fluid flow and combustion fundamentals to the design of gas turbine and rocket engines and components, including inlets, turbomachines, combustors, and nozzles. Matching of propulsion system to vehicle requirements. Must have a C- or better in pre-requisites ME 3404 and ME 3124 or AOE 3114 and AOE 3134.
Prerequisite(s): AOE 3114 and (AOE 3164 or AOE 3264) or ME 3414 and ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4234

ME 4324 - Energy Systems: Theory and Applications (3 credits)
Theory and applications of thermodynamic and fluid mechanics principles as applied to energy systems. Fundamental concepts on exergy, mixtures, psychrometry and thermochemistry. Analyses and applications include vapor and gas power systems, refrigeration, air conditioning, combustion processes and one-dimensional compressible flow.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4344 - Biological Transport Phenomena (3 credits)
Engineering analysis and predictive modeling of heat and mass transport in biological systems (e.g., tissues, organs, organisms, and biomedical devices). Examination of processes that involve conduction, convection, diffusion, generation/consumption. Application of analytical and computational methods to solve differential equations that describe unsteady and/or multi-dimensional transport. Topics include oxygen transport, pharmacokinetic analysis, kidney function, blood perfusion, burns, and cryopreservation.
Prerequisite(s): (CHE 3114 and CHE 3044 and CHE 3144) or (ME 3304 and ME 3404)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHE 4304

ME 4454 - Engineering Leadership in Practice: Managing the Technical Design Process (3 credits)
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor.
Prerequisite(s): ME 4015
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: EDCI 4454

ME 4464 - Introduction to Compressible Flows (3 credits)
Derivation of mass, momentum, and energy conservation equations for one dimensional (1-D), steady, inviscid, compressible gas flows of calorically perfect gases. Departure from incompressible flow theory. Importance of Mach number. Isentropic flows. Steady and unsteady 1-D normal shock flows. Oblique shock flows (with surface reflections) and/or Prandtl-Meyer expansion waves. Converging and converging-diverging quasi-1-D nozzle flows. Inviscid flows in straight ducts with heat addition; adiabatic flows in straight ducts with friction. Introduction to Newtonian hypersonic flow theory, high temperature effects, and rarefied gas principles.
Prerequisite(s): ME 2134 and ME 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4504 - Dynamic Systems - Controls Engineering I (3 credits)
Fundamentals of feedback control theory, classical analysis and design techniques for automatic controls, introduction to modern control theory.
Prerequisite(s): (ME 3514 and MATH 2214) or (ME 3514 and MATH 2214H) or (ME 3514 and MATH 2405H and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4524 - Introduction to Robotics and Automation (3 credits)
Automation, robot technology, kinematics, dynamics, trajectory planning, and control of two-dimensional and spatial robots; robot programming; design and simulation of robotic devices.
Prerequisite(s): ME 2004 and ME 3524 and ME 3534
Corequisite(s): ME 4584
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4534 - Land Vehicle Dynamics (3 credits)
Analytical methods for land vehicle dynamics. Mechanics of pneumatic tires on pavement and steel wheels on rails. Vehicle stability, handling, response to random guideway and roadway irregularities, ride quality computation methods and standards, suspension design.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4544 - Automotive Engineering (3 credits)
Vehicle performance, drive train, suspension, steering, and brake systems. Steady state and transient conditions. Senior standing in Mechanical Engineering required.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4554 - Advanced Technology for Motor Vehicles (3 credits)
Energy use and environmental issues for motor vehicles: Emissions standards, fleet requirements, dynamometer testing, fuel economy, and vehicle performance. Alternative fuel vehicles: Characteristics and infrastructure of fuels, batteries, electric vehicles, and hybrid electric vehicles. Vehicle design: Modeling and simulation of vehicle energy use and performance, component sizing. Fuel cells for transportation. Heavy-duty vehicles and busses. Low mass vehicles and future vehicle technology.
Prerequisite(s): ME 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4564 - Vehicle Control (3 credits)
Overview of vehicle control systems and control algorithms for anti-lock braking, stability, road holding, lane departure, traction control, and tire pressure monitoring. Advanced driver assist systems and intelligent tire technology. Hands-on experience with hardware-in-the- loop systems. Mathematical modeling and simulation of vehicle control.
Prerequisite(s): ME 3524 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4584 - Robotics Laboratory (1 credit)
Develop, compile, and test algorithms for serial and mobile robots. Robot forward and inverse kinematics, task planning, velocity kinematics, force rendering, control, haptics, mapping and localization, computer vision and path planning.
Corequisite(s): ME 4524 or ECE 4704
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ECE 4584

ME 4614 - Mechanical Design II (3 credits)
Design of mechanical elements such as welded joints hydrodynamic bearings, spur gears, shafts, brakes. Alternative fatigue design methods, cumulative fatigue, mechanical design computer software.
Prerequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4624 - Finite Element Practice in Mechanical Design (3 credits)
Application of the finite element method to stress analysis problems in mechanical design. Modeling techniques, proper use of existing computer programs, interpreting of results, application to design modification.
Prerequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4634 - Introduction to Computer-aided Design and Manufacturing (3 credits)
Participants will study the computer-aided design and manufacturing of mechanical systems. A mechanical system will be designed including preliminary design, analysis, detail design, numerical control programming, and documentation. Applications programs will be written and interfaced to the CAD/CAM database. All assignments will be carried out on a CAD/CAM system.
Prerequisite(s): ME 3024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

ME 4644 - Introduction to Rapid Prototyping (3 credits)
Participants will study topics fundamental to rapid prototyping and automated fabrication, including the generation of suitable CAD models, current rapid prototyping fabrication technologies, their underlying material science, the use of secondary processing, and the impact of these technologies on society. The rapid prototyping process will be illustrated by the actual design and fabrication of a part. Programming skills required.
Prerequisite(s): ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4654 - Optimization Techniques in Engineering (3 credits)
Fundamental mathematical concepts for optimization and optimality conditions. Classification of optimization techniques/problems in engineering. Concepts of forward and inverse design. Linear programming. Step-size calculation methods. Search direction calculation methods. 1st and 2nd order gradient-based algorithms. Evolutionary strategies for optimization. Pattern search/genetic algorithm. Sensitivity analysis. Reliability-based and robustness-based optimization.
Prerequisite(s): ME 2004 or (AOE 2074 and CS 1044 and CS 1054 and CS 1064 and CS 1114 and CS 1124 and ECE 1574)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4664 - Introduction to Global Collegiate Engineering Design (3 credits)
Participants will study topics fundamental to global collaborative engineering design, product data management, and collaborative product data management. These topics will be applied during a team project with team members located overseas, utilizing state-of-the-art collaborative engineering and product data management software and hardware technologies. Partially duplicates 5664. Credit may only be received for one course.
Prerequisite(s): ME 3024
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4674 - Materials Selection in Mechanical Design (3 credits)
Systematic approach to materials selection accounting for market need, functional requirements, shape, safety, cost and environmental issues. Overview of design process, material property charts, material indices, selection of materials with multiple constraints and/or conflicting objectives, shape factors, design considerations in hybrid materials, environmental issues as well as several case studies.
Prerequisite(s): ESM 2204 and MSE 2034
Corequisite(s): ME 3624
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4684 - Industrial Internet of Things (3 credits)
Theory and applications of Industrial Internet of Things (IIoT). Industrial data flow, devices and network in manufacturing. Basics for IIoT architecture and implementation of IIoT solutions with cloud computing platforms and OEM IIoT platforms. Device connection, data transfer and application of diagnostics, maintenance, and predictive data analytics on IIoT platforms.
Prerequisite(s): ME 3534 or (CS 1044 or CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4724 - Engineering Acoustics (3 credits)
Basic acoustical theory and practice, acoustic terminology, measurement, transmission, and perception of sound, muffler design, noise control techniques.
Prerequisite(s): ME 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4734 - Robotics and Mechatronics Seminar (1 credit)
Topics in robotics and mechatronics. Invited lectures from industry, government organizations and universities. Recent research results, developments and challenges, providing a global and social context for the topics.
Prerequisite(s): ME 3534 and ECE 3254
Instructional Contact Hours: (1 Lec, 1 Crd)

ME 4735 - Mechatronics (3 credits)
Electromechanical system modeling, control and applications. Design and building of electronic interfaces and controllers for mechanical devices, sensors, signal acquisition, filtering, and conditioning. Microcontroller-based closed-loop control and device communications. Sensor and actuator selection, installation, and application strategies are studied. A term design project is a key component to this course (for 4736).
Prerequisite(s): (ECE 3254 and ME 3514) or (ECE 2004 and ECE 2704)
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4736 - Mechatronics (3 credits)
Electromechanical system modeling, control and applications. Design and building of electronic interfaces and controllers for mechanical devices, sensors, signal acquisition, filtering, and conditioning. Microcontroller-based closed-loop control and device communications. Sensor and actuator selection, installation, and application strategies are studied. A term design project is a key component to this course (for 4736).
Prerequisite(s): ME 4735
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4744 - Mechatronics: Theory and Application (4 credits)
Electromechanical design and control applications. Theory, modeling, simulation, analysis, design and building of electronic interfaces and controllers; sensors and actuators; software development, micro-controller technology, and applications. Design Lab/Studio.
Prerequisite(s): ME 3534 and ECE 3254 and (CS 1044 or ECE 1574 or CS 2505)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

ME 4754 - Mechatronics: Advanced Topics and Application (3 credits)
Electromechanical design and control applications. Design and building of electronic interfaces and controllers including sensors, actuators, signal acquisition, filtering, and conditioning for applications. Systems integration with wireless communication; image processing; embedded programs for data acquisition and feedback control applications.
Prerequisite(s): ME 4744
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4764 - Audio Engineering Technology (3 credits)
Principles and design in the field of audio engineering. Loudspeaker design and construction, microphone technology, digital audio acquisition, signal processing in audio engineering, human perception, technical acoustics, binaural hearing, surround sound processing and production, theory, measurement, and reproduction of 3D surround sound, virtual instrument theory and practice, room acoustics and simulation, principles of audio effects (e.g., compression, reverberation, equalization), and acoustic materials engineering.
Prerequisite(s): ME 3524 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4824 - Introduction to Human-Robot Interaction (3 credits)
Formalizing interaction between robots and humans. Developing learning and control algorithms that enable robots to seamlessly and intelligently collaborate with humans. Mathematical approaches to human-robot interaction, learning from demonstration, Bayesian inference, intent detection, safe and optimal control, assistive autonomy, and user study design. Review and present existing literature.
Prerequisite(s): ME 4524
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4854 - Nano and Micromechanics of Materials (3 credits)
Analysis of microstructural mechanics, crystal structures, defects, and dislocations. Mechanical behavior of crystalline materials at the microscale. Computational modeling of mechanical behavior in discrete atomistic and molecular systems, including molecular dynamics. Application of these methods to polymers and other soft materials, biological materials, carbon-based materials, and metallic alloys.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4864 - Micro/Nano-Robotics (3 credits)
Overview of Micro/Nano-robotic systems. Physics of reduced length scales (scaling effects in the physical parameters, surface forces, contact mechanics, and Micro/Nano-scale dynamical phenomena), Basics of Micro/Nano-manufacturing, microfabrication and soft lithography, Biomimetic design strategies for mobile micro-robots, Principle of transduction, material properties and characteristics of Micro/Nano-actuators (piezoelectric, shape-memory alloy, and a variety of MEMS and polymer actuators), Control requirements and challenges of Micro/Nano-actuators, Micro/Nano sensors for mobile microrobotic applications, Micro/Nano-manipulation (scanning probe microscopy, operation principles, designing experiments for nanoscale mechanical characterization of desired samples).
Prerequisite(s): ME 3414 and ME 3624 and ME 3534
Instructional Contact Hours: (3 Lec, 3 Crd)

ME 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

ME 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4984A - Special Study (1-19 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: Variable credit course

ME 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ME 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (NSEG)

NSEG 3145 - Fundamentals of Nuclear Engr (3 credits)
Application of fundamental principles of neutron physics and reactor theory. Introduction to nuclear cross-section data, neutron scattering, nuclear fission, and diffusion theory. Examination of current and next generation nuclear power.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 3146 - Fundamental of Nuclear Engr (3 credits)
Application of fundamental principles of neutron physics and reactor theory. Calculation of critical mass and dimensions of a reactor using modified one-group theory; reactivity changes in the core due to control rods, chemical boron shim, temperature changes, and fissioin production poisons. Determination of reactor thermal design criteria. Introduction to radiation protection and reactor accident analysis. Nuclear enginering ethics principles.
Prerequisite(s): NSEG 3145 or ME 3145
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 3604 - Radiation Detection, Protection and Shielding (3 credits)
Radioactive decay, interaction of charged particles and photons with matter, methods of radiation detection and radiation dosimetry, counting statistics, radiation protection criteria and exposure limits, external radiation protection using time, distance and shielding.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214 or MATH 2214H or MATH 2406H.
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4204 - Nuclear Fuel Cycle (3 credits)
Uranium nuclear fuel cycle: radiation basics, uranium reserves, mining, conversion, enrichment, fuel manufacturing, in-core fuel management and refueling, spent fuel storage, reprocessing/recycling and final disposition as waste in a geologic repository. Introduction to nuclear safeguards and nonproliferation as applied to each step of cycle. Alternative fuel cycles.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Corequisite(s): NSEG 3146
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4214 - Nuclear Power Plant Operations (3 credits)
Emphasis on pressurized water reactor plant operations. Review of boiling water reactor operations. Detailed system functions and operation, reactor plant startup and shutdown procedures, reactor refueling, reactor plant safety analysis, reactor plant licensing, ethics and integrity in the nuclear industry.
Prerequisite(s): NSEG 3145
Corequisite(s): NSEG 3146
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4424 - Reactor Thermal Hydraulics (3 credits)
Fundamental processes of heat generation and transport in nuclear reactors: reactor coolant systems and components, heat generation and spatial distribution, heat transport by conduction and convection, single-phase flow, two-phase flow and boiling, critical heat flux.
Prerequisite(s): MATH 2214 or MATH 2214H or MATH 2406H
Corequisite(s): NSEG 3145
Instructional Contact Hours: (3 Lec, 3 Crd)

NSEG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NSEG 4994H - Undergraduate Research (1-19 credits)
Honors Section
Instructional Contact Hours: Variable credit course

Automotive Engineering Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ME 2004	Engineering Analysis Using Numerical Methods	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3624	Mechanical Design (w lab)	4
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
Subtotal		21
Major Requirements		
ME 4534	Land Vehicle Dynamics	3
ME 4544	Automotive Engineering	3
ME 4564	Vehicle Control	3
Select 9 credits of technical electives from the list shown.		9
Subtotal		18
Additional Course Requirements		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ECE 2054	Applied Electrical Theory	3
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
ME 2134	Thermodynamics	4
ME 3524	Mechanical Vibrations	4
MSE 2034	Elements of Materials Engineering	3
STAT 3704	Statistics for Engineering Applications	2
Subtotal		36
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ME 3024	Engineering Design and Economics (1A)	3
ME 3034	Mechanical Engineering Discourse (1A)	1
ME 4015 & ME 4016 or ENGE 4735 & ENGE 4736	Engineering Design and Project and Engineering Design and Project (1A) [2] Interdisciplinary Design Capstone and Interdisciplinary Design Capstone	6
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [1]	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select a course with covers both Concept 7 and Pathways Concept 2 or 3 to avoid taking additional credits.		
Subtotal		54
Total Credits		**129**

1. Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH1225 to proceed to other MATH courses such as MATH1226 and MATH2114.
2. All students should enroll in ME4015. Students interested in joining an ENGE4735/4736 senior design project should apply through the ME4015 senior design coordinator during the project selection process at the start of the Fall semester. Because participation in all projects is limited, students are not guaranteed a seat in any particular project. Grades earned in ENGE4735/4736 will also count towards a student's in-major GPA. Students must meet all ME4015 prerequisites to be eligible to enroll in ENGE4735.

Technical Electives

The Automotive Engineering major requires 9 credits of approved technical electives from list. No more than 6 of these credits can be taken Pass/Fail. Please see attached list for technical elective choices.

Code	Title	Credits
ECE 3254	Industrial Electronics	3
ME 3604	Kinematics and Dynamics of Machinery	3
ME 4204	Internal Combustion Engines	3
ME 4554	Advanced Technology for Motor Vehicles	3
ME 4614	Mechanical Design II	3
ME 4624 or ME 5634	Finite Element Practice in Mechanical Design [2,3] Finite Elements in Machine Design	3
ME 4634	Introduction to Computer-aided Design and Manufacturing	3
ME 4644 or ME 5644	Introduction to Rapid Prototyping [2,3] Rapid Prototyping	3
ME 4654 or ME 5794	Optimization Techniques in Engineering [2,3] Optimization Techniques in Engineering	3
ME 4674	Materials Selection in Mechanical Design	3
ME 4744	Mechatronics: Theory and Application	4
ME 4974	Independent Study [1]	1-19
ME 4994	Undergraduate Research [1]	1-19

1. Independent study and undergraduate research must be automotive-related and requires departmental/major approval. No more than 6 credits total of independent study and/or undergraduate research can

count towards technical elective requirement. Consult undergraduate advisor with questions.

[2] Students not already accepted into the accelerated BS/MS graduate program should plan to take the 4000-level version of these classes.

[3] Students within 2 semesters of graduating who have a minimum overall GPA of 3.0 or higher who have not been accepted into an accelerated BS/MS program may request permission to enroll in a 5000-level ME course provided that: (1) an undergraduate version of the course is not available, (2) the student cannot otherwise complete the major with current undergraduate course offerings, and (3) the student has earned a B or higher in all previous ME courses. Permission from both the ME department head and the course instructor are required for the student to enroll in a 5000-level ME course. These courses may not be used on the Plan of Study for a graduate degree at Virginia Tech.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ME Department fully supports this policy. Specific expectations for satisfactory progress for Mechanical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog http://www.undergradcatalog.registrar.vt.edu/
- Once a student is in the ME major, a student must:
  - Within 2 semesters of entering ME Department, complete PHYS2305, ENGL1106, CHEM1035, MATH2114, and ME2004
  - Within 3 semesters of entering ME Department, complete ME2134
  - Complete a minimum of 12 credits that apply toward a BSME degree during each 12 month period
  - Maintain an in-major GPA of at least 2.00. In-major is calculated using all courses taught under the ESM, ME, and NSEG designators and ENGE 4735 and ENGE 4736 if applicable .
  - Complete ESM 2104 Statics, MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus within 50 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ESM 2304 Dynamics, ME 2004 Engineering Analysis Using Numerical Methods and MATH 2214 Introduction to Differential Equations within 69 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ME 2134 Thermodynamics, ME 3524 Mechanical Vibrations, and (ME 3024 Engineering Design and Economics or ME 3624 Mechanical Design) with 87 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ME 4015 Engineering Design and Project and ME 4544 Automotive Engineering within 104 attempted required course credits (not to include Pathways courses, technical electives or free electives)

Graduation Requirements

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is determined from all courses with Engineering Science and Mechanics (ESM), Mechanical Engineering (ME), and Nuclear Engineering (NSEG) designators and ENGE 4735/ENGE 4736 if applicable.

Required courses in the Automotive Engineering "Major Requirements" category (ME 4534, ME 4544, and ME 4564) and electives in the "Technical Elective" category cannot be double-counted as technical electives towards a second Mechanical Engineering (BSME) major.

General Information about Checksheet

Course offerings are subject to change based on course enrollment and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Statement of Prerequisites

Prerequisites may change. Students are responsible for pre-requisites and pre-requisites of pre-requisites whether specifically listed in the Undergraduate Course Catalog or not.

Be sure to consult the University Timetable of Classes or check with your advisor for the most current prerequisite requirements. Note that some courses, such as MATH 1225, may have a minimum grade requirement to move on to other courses at Virginia Tech, such as MATH 2114 and MATH 1226.

Acceptable Substitutions

1. MATH 2405H (5 cr) may be substituted for MATH 2114 (3 cr)
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + MATH 2214 (3 cr)
3. STAT 4604 (3 cr), STAT 4705 (3 cr), or STAT 4714 (3 cr) may be substituted for STAT 3704 (2)
4. MSE 2044 (4 cr) may be substituted for MSE 2034 (3 cr).

Foreign Language Requirement

Foreign Language Requirements

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable [1]	4
ENGE 1215	Foundations of Engineering	2
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable [1]	4

MATH 2114	Introduction to Linear Algebra [1]	3
ENGE 1216	Foundations of Engineering	2
PHYS 2305	Foundations of Physics (w/lab)	4
	Credits	**16**
Second Year		
Fall Semester		
ESM 2104	Statics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics	4
MSE 2034	Elements of Materials Engineering	3
ME 2004	Engineering Analysis Using Numerical Methods	3
	Credits	**17**
Spring Semester		
ECE 2054	Applied Electrical Theory	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
ME 2134	Thermodynamics	4
	Credits	**16**
Third Year		
Fall Semester		
STAT 3704	Statistics for Engineering Applications	2
ME 3024	Engineering Design and Economics	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3524	Mechanical Vibrations	4
ME 3624	Mechanical Design (w lab)	4
	Credits	**17**
Spring Semester		
ME 4544	Automotive Engineering	3
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
ME 3034	Mechanical Engineering Discourse	1
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**17**
Fourth Year		
Fall Semester		
ME 4015	Engineering Design and Project	3
ME 4564	Vehicle Control	3
Technical Electives		3
Technical Electives		3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**15**
Spring Semester		
ME 4016	Engineering Design and Project	3
ME 4534	Land Vehicle Dynamics	3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
Technical Electives		3
	Credits	**15**
	Total Credits	**129**

1. Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH1225 to proceed to other Virginia Tech MATH courses such as MATH1226 and MATH2114.
2. If enrolling in a Pathways Concept 7 elective, choose one that also covers either Concept 2 or 3 to avoid taking 3 additional credits to meet graduation requirements.

Mechanical Engineering Major

Program Curriculum

Credits Required For Graduation: 129

Code	Title	Credits
Degree Core Requirements		
ME 2004	Engineering Analysis Using Numerical Methods	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3624	Mechanical Design (w lab)	4
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
Subtotal		21
Major Requirements		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ECE 2054	Applied Electrical Theory	3
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
ME 2134	Thermodynamics	4
ME 3524	Mechanical Vibrations	4
MSE 2034	Elements of Materials Engineering	3
STAT 3704	Statistics for Engineering Applications	2
Subtotal		36
Technical Electives		
Select 15 credits from the list of Technical Electives		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ME 3024	Engineering Design and Economics (1A)	3
ME 3034	Mechanical Engineering Discourse (1A)	1
ME 4015 & ME 4016	Engineering Design and Project and Engineering Design and Project (1A) [2]	6
or ENGE 4735 & ENGE 4736	Interdisciplinary Design Capstone and Interdisciplinary Design Capstone	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [1]	4

MATH 1226	Calculus of a Single Variable (5F) [1]	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (6D) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [3]		3
Subtotal		57
Total Credits		**129**

1. Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH 1225 to proceed to other Virginia Tech MATH courses such as MATH 1226 and MATH 2114.
2. All students should enroll in ME 4015. Students interested in joining an ENGE 4735/ENGE 4736 senior design project should apply through the ME4015 senior design coordinator during the project selection process at the start of the Fall semester. Because participation in all projects is limited, students are not guaranteed a seat in any particular project. Grades earned in ENGE 4735/ENGE 4736 will also count towards a student's in-major GPA. Students must meet all ME 4015 prerequisites to be eligible to enroll in ENGE 4735.
3. If one course is used to satisfy both Pathways Concept 7 and another Pathways Concept, additional free elective credits may be required to reach the minimum 129 credits required for graduation.

Technical Electives

Technical elective requirements are satisfied by one of two different paths. Note that required courses listed as "Major Requirements" or used to satisfy Technical Elective requirements for other BSME majors may not be double-counted as Technical Electives towards this general Mechanical Engineering major.

Path 1: Fifteen credit hours of approved technical electives. Nine of the fifteen elective credit hours must be 3000-level or higher Engineering Science and Mechanics (ESM), Mechanical Engineering (ME) or Nuclear Engineering (NSEG) courses. A maximum of three credits of technical elective may be taken from Technical Elective List #2. Up to six credits of technical electives may be taken Pass/Fail. Not all technical electives are offered in the Pass/Fail grade mode. See the list below for technical elective choices.

Path 2: Complete one of the following minors and fifteen elective credit hours from the list of electives associated with Path 1. Only three of the fifteen elective credits may be taken from List #2.
Accepted minors under Path 2: Biomedical Engineering, Computer Science, Green Engineering, Physics. Consult academic advisor if pursuing a math, science, or engineering-related second major or minor to see if it might qualify for a waiver of the minimum 9 credits ME/NSEG-subject tech electives.

Technical Elective List #1

Code	Title	Credits
Aerospace and Ocean Engineering (AOE)		
Select any 3000 or 4000 level AOE course EXCEPT the following:		
AOE 3014	Fluid Dynamics for Aerospace and Ocean Engineers	
AOE 3034	System Dynamics and Control	
AOE 3044	Boundary Layer and Heat Transfer	
AOE 3054	Experimental Methods	
AOE 3984	Special Study [1]	
AOE 4004	State-Space Control	
AOE 4024	An Introduction to the Finite Element Method	
AOE 4065	Air Vehicle Design	
AOE 4066	Air Vehicle Design	
AOE 4105	Experiments for Aerospace Design	
AOE 4106	Experiments for Aerospace Design	
AOE 4165	Space Vehicle Design	
AOE 4166	Space Vehicle Design	
AOE 4205	Experiments for Ocean Vehicle Design	
AOE 4206	Experiments for Ocean Vehicle Design	
AOE 4265	Ocean Vehicle Design	
AOE 4266	Ocean Vehicle Design	
AOE 4974	Independent Study [2]	
AOE 4984	Special Study [1]	
AOE 4994	Undergraduate Research [2]	
Biological Systems Engineering (BSE)		
Select any 3000 or 4000 level BSE course EXCEPT the following:		
BSE 3014	Introduction to Fluid Mechanics	
BSE 3144	Engineering Analysis for Biological Systems using Numerical Methods	
BSE 3154	Thermodynamics of Biological Systems	
BSE 3504	Transport Processes in Biological Systems	
BSE 3954	Study Abroad	
BSE 3984	Special Study [1]	
BSE 4304	Introduction to Watershed Modeling	
BSE 4125	Comprehensive Design Project	
BSE 4126	Comprehensive Design Project	
BSE 4204	Instrumentation for Biological Systems	
BSE 4224	Field Methods in Hydrology	
BSE 4974	Independent Study	
BSE 4984	Special Study	
BSE 4994	Undergraduate Research	
Biomedical Engineering (BMES)		
Select any non-duplicating 3000 or higher level BMES courses EXCEPT the following:		
BMES 3004	Helmet Design: Biomechanics to Health & Social Disparities in Sports	
BMES 3984	Special Study [1]	
BMES 4015	BME Senior Design and Project	
BMES 4016	BME Senior Design and Project	
BMES 4974	Independent Study [2]	
BMES 4984	Special Study [1]	
BMES 4994	Undergraduate Research [2]	
Building Construction (BC)		
Select any 3000 or 4000 level BC course EXCEPT the following:		
BC 3954	Study Abroad	
BC 3984	Special Study [1]	

BC 4974	Independent Study [2]	
BC 4984	Special Study [1]	
BC 4994	Undergraduate Research [2]	
Construction Engineering and Management (CEM)		
Select any 3000 or 4000 level CEM course EXCEPT the following:		
CEM 3984	Special Study [1]	
CEM 4024	Construction Law and Contract Administration	
CEM 4445	CEM Capstone	
CEM 4446	CEM Capstone	
CEM 4974	Independent Study [2]	
CEM 4984	Special Study [1]	
CEM 4994	Undergraduate Research [2]	
Chemical Engineering (CHE)		
Select any 3000 or 4000 level CHE course EXCEPT the following:		
CHE 3015	Process Measurement & Control	
CHE 3044	Heat Transfer	
CHE 3114	Fluid Transport	
CHE 3124	Chemical Engineering Simulations and Process Modeling	
CHE 3984	Special Study [1]	
CHE 4014	Chemical Engineering Laboratory	
CHE 4024	Unit Operations and Scale-Up	
CHE 4144	Business and Marketing Strategies for the Process Industries	
CHE 4304	Biological Transport Phenomena	
CHE 4974	Independent Study [2]	
CHE 4984	Special Study [1]	
CHE 4994	Undergraduate Research [2]	
Chemistry (CHEM)		
CHEM 3615	Physical Chemistry	3
CHEM 3616	Physical Chemistry	3
CHEM 3625	Physical Chemistry Laboratory	1
CHEM 3626	Physical Chemistry Laboratory	1
CHEM 4074	Laboratory in Polymer Science	2
CHEM 4114	Instrumental Analysis	3
CHEM 4124	Instrumental Analysis Laboratory	1
CHEM 4404	Physical Inorganic Chemistry	3
CHEM 4424	Polysaccharide Chemistry	3
CHEM 4524	Identification of Organic Compounds	3
CHEM 4534	Organic Chemistry of Polymers	3
CHEM 4554	Drug Chemistry	3
CHEM 4615	Physical Chemistry for the Life Sciences	3
CHEM 4616	Physical Chemistry for the Life Sciences	3
CHEM 4634	Polymer and Surface Chemistry	3
CHEM 4734	Environmental Soil Chemistry	3
Civil and Environmental Engineering (CEE)		
Select any 3000 or 4000 level CEE course EXCEPT the following:		
CEE 3304	Fluid Mechanics for Civil and Environmental Engineering	
CEE 3684	Civil Engineering Materials	
CEE 3954	Study Abroad	
CEE 3984	Special Study [1]	
CEE 4804	Professional and Legal Issues in Civil Engineering	
CEE 4974	Independent Study [2]	
CEE 4984	Special Study [1]	
CEE 4994	Undergraduate Research [2]	
Computer Science (CS)		
CS 3114	Data Structures and Algorithms	3
CS 3214	Computer Systems	3
CS 3304	Comparative Languages	3
CS 3414	Numerical Methods	3
CS 3704	Intermediate Software Design and Engineering	3
CS 3714	Mobile Software Development	3
CS 3724	Introduction to Human-Computer Interaction	3
CS 3744	Introduction to GUI Programming and Graphics	3
CS 3754	Cloud Software Development	3
CS 3824	Introduction to Computational Biology and Bioinformatics	3
CS 4104	Data and Algorithm Analysis	3
CS 4114	Introduction to Formal Languages and Automata Theory	3
CS 4204	Computer Graphics	3
CS 4214	Simulation and Modeling	3
CS 4234	Parallel Computation	3
CS 4244	Internet Software Development	3
CS 4254	Computer Network Architecture and Programming	3
CS 4304	Compiler Design and Implementation	3
CS 4414	Issues in Scientific Computing	3
CS 4504	Computer Organization	3
CS 4570	Wireless Networks and Mobile Systems	3
CS 4604	Introduction to Data Base Management Systems	3
CS 4704	Software Engineering Capstone	3
CS 4804	Introduction to Artificial Intelligence	3
CS 4824	Machine Learning	3
Electrical and Computer Engineering (ECE)		
Select any 3000 or 4000 level ECE course EXCEPT the following:		
ECE 3004	AC Circuit Analysis	
ECE 3054	Electrical Theory	
ECE 3074	AC Circuit Analysis Laboratory	
ECE 3704	Continuous and Discrete System Theory	
ECE 3714	Introduction to Control Systems	
ECE 3974	Independent Study	
ECE 3984	Special Study [1]	
ECE 4584	Robotics Laboratory	
ECE 4704	Principles of Robotics Systems	
ECE 4805	Senior Design Project	
ECE 4806	Senior Design Project	
ECE 4974	Independent Study [2]	
ECE 4984	Special Study [1]	
ECE 4994	Undergraduate Research [2]	
Engineering (ENGR)		
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
Engineering Science and Mechanics (ESM)		
Select any 3000 or 4000 level ESM course EXCEPT the following:		

ESM 3024	Introduction to Fluid Mechanics	
ESM 3034	Fluid Mechanics Laboratory	
ESM 3114	Problem Definition and Scoping in Engineering Design	
ESM 3134	Dynamics III - Vibration and Control	
ESM 3234	Fluid Mechanics I-Control Volume Analysis	
ESM 3444	Mechanics Laboratory	
ESM 4015	Creative Design and Project	
ESM 4016	Creative Design and Project	
ESM 4194	Sustainable Energy Solutions for a Global Society	
ESM 4404	Fundamentals of Professional Engineering	
ESM 4974	Independent Study [2]	
ESM 4984	Special Study [1]	
ESM 4994	Undergraduate Research [2]	
Geological Sciences (GEOS)		
GEOS 3104	Elementary Geophysics	3
GEOS 4164	Potential Field Methods in Exploration Geophysics	4
Industrial and Systems Engineering (ISE)		
Select any 3000 or 4000 level ISE course EXCEPT the following:		
ISE 3984	[2]	
ISE 4005	Project Management and Systems Design	
ISE 4006	Project Management and Systems Design	
ISE 4974	Independent Study [2]	
ISE 4984	Special Study [1]	
ISE 4994	Undergraduate Research [2]	
Materials Science and Engineering (MSE)		
Select any 3000 or 4000 level MSE course EXCEPT the following:		
MSE 3114	Mathematics Programming in Materials Science II	
MSE 3354	Foundry Safety	
MSE 3884	Materials Engineering Professional Development II	
MSE 3954	Study Abroad	
MSE 3984	[1]	
MSE 4075	Senior Design Laboratory	
MSE 4076	Senior Design Laboratory	
MSE 4085	Senior Capstone Recitation	
MSE 4086	Senior Capstone Recitation	
MSE 4095H	Honors Senior Design-Laboratory	
MSE 4096H	Honors Senior Design Laboratory	
MSE 4974	Independent Study [2]	
MSE 4984	Special Study [1]	
MSE 4994	Undergraduate Research [2]	
Mathematics (Math)		
MATH 3034	Introduction to Proofs	3
MATH 3214	Calculus of Several Variables	3
MATH 3224	Advanced Calculus	3
MATH 4124	Introduction to Abstract Algebra	3
MATH 4175	Cryptography	3
MATH 4225	Elementary Real Analysis	3
MATH 4226	Elementary Real Analysis	3
MATH 4234	Elementary Complex Analysis	3
MATH 4245	Intermediate Differential Equations	3
MATH 4246		3
MATH 4425	Fourier Series and Partial Differential Equations	3
MATH 4426	Fourier Series and Partial Differential Equations	3
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4564	Operational Methods for Engineers	3
MATH 4574	Vector and Complex Analysis for Engineers	3
Mechanical Engineering (ME)		
Select any non-required or non-duplicating 3000 or higher level ME course EXCEPT the following:		
ME 3984	Special Study [1]	
ME 4454	Engineering Leadership in Practice:Managing the Technical Design Process	
ME 4974	Independent Study [2]	
ME4984	[1]	
ME 4994	Undergraduate Research [2]	
Mining and Minerals Engineering (MINE)		
Select any 3000 and 4000 level MINE course EXCEPT the following:		
MINE 3984	Special Study [1]	
MINE 4635	Mining Engineering Capstone	
MINE 4636	Mining Engineering Capstone	
MINE 4664	Resource Engineering Leadership Seminar	
MINE 4974	Independent Study [2]	
MINE 4984	Special Study [1]	
MINE 4994	Undergraduate Research [2]	
Nuclear Engineering (NSEG)		
Select any non-duplicating 3000 or higher level NSEG course EXCEPT the following:		
NSEG 3984	[1]	
NSEG 4974	Independent Study [2]	
NSEG 4984	Special Study [1]	
NSEG 4994	Undergraduate Research [2]	
Physics (PHYS)		
PHYS 3355	Intermediate Mechanics	3
PHYS 3356	Intermediate Mechanics	3
PHYS 3405	Intermediate Electricity and Magnetism	3
PHYS 3406	Intermediate Electricity and Magnetism	3
PHYS 3655	Introduction to Astrophysics	3
PHYS 3656	Introduction to Astrophysics	3
PHYS 3704	Thermal Physics	3
PHYS 4315	Modern Experimental Physics	2
PHYS 4316	Modern Experimental Physics	2
PHYS 4455	Introduction to Quantum Mechanics	3
PHYS 4456	Introduction to Quantum Mechanics	3
PHYS 4504	Introduction to Nuclear and Particle Physics	3
PHYS 4554	Introduction to Solid State Physics	3
PHYS 4574	Nanotechnology	3
PHYS 4614	Optics	3
PHYS 4624	Optics Laboratory	1
PHYS 4674	Introduction to General Relativity	3
PHYS 4714	Introduction to Biophysics	3
Statistics (STAT)		
Select any 4000 level Stat course EXCEPT the following:		
STAT 4524	Sample Survey Methods	

STAT 4604	Statistical Methods for Engineers	
STAT 4705	Probability and Statistics for Engineers	
STAT 4706	Probability and Statistics for Engineers	
STAT 4714	Probability and Statistics for Electrical Engineers	
STAT 4804	Elementary Econometrics	
STAT 4964	Field Study	
STAT 4974	Independent Study [2]	
STAT 4984	Special Study [1]	
STAT 4994	Undergraduate Research [2]	
Urban Affairs and Planning (UAP)		
UAP 4374	Land Use and Environment: Planning and Policy	3
UAP 4394	Community Renewable Energy Systems	3

1 Any 2984, 3984, 4984 course from any department on List #1 or #2 must be approved on an individual course basis; see departmental advisor to request technical elective credit for these courses. The approval process for these courses will also determine whether they count toward the 3 credit limit associated with List #2.

2 Any 4974, 4994, and 5974 course from any department on List #1 or #2 other than ME must be approved on an individual course basis; see departmental advisor to request technical elective credit for these courses. All 4974, 4994, and 5974 courses (whether from ME or another department) count toward the 3 credit limit associated with List #2.

Technical Elective List #2

Code	Title	Credits
Agricultural, Leadership, and Community Education (ALCE)		
ALCE 2484	Engine and Power Train Technology	3
Biomedical Engineering (BMES)		
BMES 2104	Introduction to Biomedical Engineering	3
Chemistry (CHEM)		
CHEM 2514	Survey of Organic Chemistry	3
Computer Science (CS)		
CS 2114	Software Design and Data Structures	3
CS 2505	Introduction to Computer Organization	3
English (ENGL)		
ENGL 4804	Grant Proposals and Reports	3
Education, Curriculum & Instruction (EDCI)		
EDCI 4454	Engineering Leadership in Practice:Managing the Technical Design Process	3
Electrical & Computer Engineering (ECE)		
ECE 2164	Exploration of the Space Environment	3
Engineering Education (EngE)		
ENGE 4094	Startup: Commercialization of Innovation	3
Industrial Design (IDS)		
IDS 2044	Human Factors	3
IDS 3124	Materials and Processes	3
Mechanical Engineering (ME)		
ME 4454	Engineering Leadership in Practice:Managing the Technical Design Process	3
Residential Environments and Design (RED)		
RED 4604	Environmental and Sustainability Issues in Housing	3

1 Any 2984, 3984, 4984 course from any department on List #1 or #2 must be approved on an individual course basis; see departmental advisor to request technical elective credit for these courses. The approval process for these courses will also determine whether they count toward the 3 credit limit associated with List #2.

2 Any 4974, 4994, and 5974 course from any department on List #1 or #2 other than ME must be approved on an individual course basis; see undergraduate ME advisor to request technical elective credit for these courses. All 4974, 4994, and 5974 courses (whether from ME or another department) count toward the 3-credit limit associated with List #2.

Note: Students are responsible for checking the prerequisite courses for any listed technical elective course. Many courses on the lists require one or more prerequisite courses which are not part of the ME curriculum which may prevent students from enrolling in these courses. Students may need to get permission from the department offering a course to sign up for non-ME courses.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ME Department fully supports this policy. Specific expectations for satisfactory progress for Mechanical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog http://www.undergradcatalog.registrar.vt.edu/
- Once a student is in the ME major, a student must:
  - Within 2 semesters of entering ME Department, complete PHYS2305, ENGL1106, CHEM1035, MATH2114, and ME2004
  - Within 3 semesters of entering ME Department, complete ME2134
  - Complete a minimum of 12 credits that apply toward the ME degree during each 12 month period
  - Maintain an in-major GPA of at least 2.00. In-major is calculated using all courses taught under the ESM, ME, and NSEG designators and ENGE4735 and ENGE4736.
  - Complete ESM 2104 Statics, MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus within 50 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ESM 2304 Dynamics, ME 2004 Engineering Analysis Using Numerical Methods and MATH 2214 Introduction to Differential Equations within 69 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ME 2134 Thermodynamics, ME 3524 Mechanical Vibrations, and (ME 3024 Engineering Design and Economics or ME 3624 Mechanical Design) with 87 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ME 4015 Engineering Design and Project within 104 attempted required course credits (not to include Pathways courses, technical electives or free electives)

Graduation Requirements

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is determined from all courses with Engineering Science and Mechanics (ESM), Mechanical Engineering (ME) and Nuclear Engineering (NSEG) designators and ENGE 4735/ENGE 4736 if applicable. Required courses or courses used to satisfy technical elective requirements for other BSME major(s) cannot be double counted as technical electives towards this general ME major.

General Information about Checksheet

Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Statement of Prerequisites

Prerequisites may change. Students are responsible for pre-requisites and pre-requisites of pre-requisites whether specifically listed in the Undergraduate Course Catalog or not.

Be sure to consult the University Timetable of Classes or check with your advisor for the most current prerequisite requirements. Note that some courses, such as MATH 1225, may have a minimum grade requirement to move on to other courses at Virginia Tech, such as MATH 2114 and MATH 1226.

Acceptable Substitutions

1. MATH 2405H (5 cr) may be substituted for MATH 2114 (3 cr)
2. MATH 2405H + MATH 2406H may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + MATH 2214 (3 cr)
3. STAT 4604 (3 cr), STAT 4705 (3 cr), or STAT 4714 (3 cr) may be substituted for STAT 3704.
4. MSE 2044 (4 cr) may be substituted for MSE 2034 (3 cr).

Foreign Language Requirement

Foreign Language Requirements

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable [1]	4
ENGE 1215	Foundations of Engineering	2
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable [1]	4
MATH 2114	Introduction to Linear Algebra [1]	3
ENGE 1216	Foundations of Engineering	2
PHYS 2305	Foundations of Physics (w/lab)	4
	Credits	**16**
Second Year		
Fall Semester		
ESM 2104	Statics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics	4
MSE 2034	Elements of Materials Engineering	3
ME 2004	Engineering Analysis Using Numerical Methods	3
	Credits	**17**
Spring Semester		
ECE 2054	Applied Electrical Theory	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
ME 2134	Thermodynamics	4
	Credits	**16**
Third Year		
Fall Semester		
STAT 3704	Statistics for Engineering Applications	2
ME 3024	Engineering Design and Economics	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3524	Mechanical Vibrations	4
ME 3624	Mechanical Design (w lab)	4
	Credits	**17**
Spring Semester		
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
ME 3034	Mechanical Engineering Discourse	1
Select three credits in Pathways 2, 3, 6A, or 7		3
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**17**
Fourth Year		
Fall Semester		
ME 4015	Engineering Design and Project	3
Technical Elective		3
Technical Elective		3
Technical Elective		3
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**15**
Spring Semester		
ME 4016	Engineering Design and Project	3
Technical Elective		3
Technical Elective		3
Select three credits in Pathways 2, 3, 6A, or 7		3
Select three credits in Pathways 2, 3, 6A, or 7		3
	Credits	**15**
	Total Credits	**129**

[1] Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH1225 to proceed to other MATH courses such as MATH1226 and MATH2114 at Virginia Tech.

Robotics and Mechatronics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
ME 2004	Engineering Analysis Using Numerical Methods	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3624	Mechanical Design (w lab)	4
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
Subtotal		21
Major Requirements		
CS 1044	Introduction to Programming in C	3
or CS 2505	Introduction to Computer Organization	
ECE 3254	Industrial Electronics	3
ME 4524	Introduction to Robotics and Automation [1]	3
or ME 5704	Robotics and Automation	
ME 4744	Mechatronics: Theory and Application	4
ME 4584	Robotics Laboratory	1
ME 4734	Robotics and Mechatronics Seminar	1
Technical Elective		3
Subtotal		18
Additional Course Requirements		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ECE 2054	Applied Electrical Theory	3
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
ME 2134	Thermodynamics	4
ME 3524	Mechanical Vibrations	4
MSE 2034	Elements of Materials Engineering	3
STAT 3704	Statistics for Engineering Applications	2
Subtotal		36
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ME 3024	Engineering Design and Economics (1A)	3
ME 3034	Mechanical Engineering Discourse (1A)	1
ME 4015 & ME 4016	Engineering Design and Project and Engineering Design and Project (1A) [2]	6
or ENGE 4735 & ENGE 4736	Interdisciplinary Design Capstone and Interdisciplinary Design Capstone	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [3]	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select a course with covers both Concept 7 and Pathways Concept 2 or 3 to avoid taking additional credits.		3
Subtotal		54
Total Credits		**129**

1 Undergraduate students not already accepted into the accelerated BS/MS graduate program should plan to take the 4000-level version of this course. Students taking ME 5704 in place of ME 4524 are NOT exempted from the 1-credit lab (ME 4584). Students within 2 semesters of graduating who have a minimum overall GPA of 3.0 or higher who have not been accepted into an accelerated BS/MS program may request permission to enroll in a 5000-level ME course provided that: (1) an undergraduate version of the course is not available, (2) the student cannot otherwise complete the major with current undergraduate course offerings, and (3) the student has earned a B or higher in all previous ME courses. Permission from both the ME department head and the course instructor are required for the student to enroll in a 5000-level ME course. These courses may not be used on the Plan of Study for a graduate degree at Virginia Tech.

2 All students should enroll in ME 4015. Students interested in joining an ENGE 4735/ENGE 4736 senior design project should apply through the ME4015 senior design coordinator during the project selection process at the start of the Fall semester. Because participation in all projects is limited, students are not guaranteed a seat in any particular project. Grades earned in ENGE 4735/ENGE 4736 will also count towards a student's in-major GPA. Students must meet all ME 4015 prerequisites to be eligible to enroll in ENGE 4735.

3 Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH 1225 to proceed to other MATH courses such as MATH 1226 and MATH 2114.

Technical Elective List

Code	Title	Credits
ME 3604	Kinematics and Dynamics of Machinery	3
ME 4034	Bio-Inspired Technology [1]	3
or ME 5034	Bio-Inspired Technology	
ME 4184	Drone Technology and Flight Operations	3
ME 4564	Vehicle Control	3
ME 4624	Finite Element Practice in Mechanical Design [1]	3
or ME 5634	Finite Elements in Machine Design	

ME 4634	Introduction to Computer-aided Design and Manufacturing	3
ME 4644	Introduction to Rapid Prototyping [1]	3
or ME 5644	Rapid Prototyping	
ME 4754	Mechatronics: Advanced Topics and Application	3
ME 4824	Introduction to Human-Robot Interaction [1]	3
or ME 5824	Algorithmic Human-Robot Interaction	
ME 4864	Micro/Nano-Robotics [1]	3
or ME 5864G	Advanced Micro/Nano-Robotics	
ME 4974	Independent Study [2]	3
ME 4994	Undergraduate Research [2]	3

Any non-duplicating ME/ECE/CS 4000-5000 level Controls course. Requires departmental approval.

[1] Undergraduate students not already accepted into the accelerated BS/MS graduate program should plan to take the 4000-level version of this course. Students within 2 semesters of graduating who have a minimum overall GPA of 3.0 or higher who have not been accepted into an accelerated BS/MS program may request permission to enroll in a 5000-level ME course provided that: (1) an undergraduate version of the course is not available, (2) the student cannot otherwise complete the major with current undergraduate course offerings, and (3) the student has earned a B or higher in all previous ME courses. Permission from both the ME department head and the course instructor are required for the student to enroll in a 5000-level ME course. These courses may not be used on the Plan of Study for a graduate degree at Virginia Tech.

[2] Independent study and undergraduate research must be robotics- or mechatronics-related and require departmental/major approval. Consult undergraduate advisor with questions.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The ME Department fully supports this policy. Specific expectations for satisfactory progress for Mechanical Engineering majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog http://www.undergradcatalog.registrar.vt.edu/
- Once a student is in the ME degree (regardless of major), a student must:
  - Complete a minimum of 12 credits that apply toward the ME degree during each 12 month period
  - Within 2 semesters of entering ME Department, complete PHYS2305, ENGL1106, CHEM1035, MATH2114, and ME2004
  - Within 3 semesters of entering ME Department, complete ME2134
  - Maintain an in-major GPA of at least 2.00. In-major GPA is calculated using all courses taught under the ESM, ME, and NSEG designators plus ENGE4735 and ENGE4736 if applicable.
  - Complete ESM 2104 Statics, MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus within 50 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ESM 2304 Dynamics, ME 2004 Engineering Analysis Using Numerical Methods and MATH 2214 Introduction to Differential Equations within 69 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete ME 2134 Thermodynamics, ME 3524 Mechanical Vibrations, and (ME 3024 Engineering Design and Economics or ME 3624 Mechanical Design) within 87 attempted required course credits (not to include Pathways courses, technical electives or free electives)
  - Complete (ME 4015 Engineering Design and Project and ME 4524 Introduction to Robotics and Automation within 104 attempted required course credits (not to include Pathways courses, technical electives or free electives)

Graduation Requirements

Graduation Requirements

Each student must complete at least 129 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is determined from all courses with Engineering Science and Mechanics (ESM), Mechanical Engineering (ME), and Nuclear Engineering (NSEG) designators and ENGE 4735 and ENGE 4736 if applicable.

Required courses in the Robotics and Mechatronics "Major Requirements" category (ECE 3254, ME 4524, ME 4744, ME 4584, and ME 4734) and courses used to satisfy the Technical Elective requirement for this major cannot be double counted towards a second Mechanical Engineering major as Technical Elective credit.

General Information about Checksheet

Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Technical Electives

The Robotics and Mechatronics major requires 3 credits of approved technical electives from list. Please see attached list for technical elective choices.

Statement of Prerequisites

Prerequisites may change. Students are responsible for pre-requisites and pre-requisites of pre-requisites whether specifically listed in the Undergraduate Course Catalog or not.

Be sure to consult the University Timetable of Classes or check with your advisor for the most current prerequisite requirements. Note that some courses, such as MATH 1225, may have a minimum grade requirement to move on to other courses at Virginia Tech such as MATH 2114 and MATH 1226.

Acceptable Substitutions

1. MATH 2405H (5 cr) may be substituted for MATH 2114 (3 cr)
2. MATH 2405H (5 cr) + MATH 2406H (5 cr) may be substituted for MATH 2114 (3 cr) + MATH 2204 (3 cr) + MATH 2214 (3 cr)
3. STAT 4604 (3 cr), STAT 4705 (3 cr), or STAT 4714 (3 cr) may be substituted for STAT 3704 (2 cr)
4. MSE 2044 (4 cr) may be substituted for MSE 2034 (3 cr)

Foreign Language Requirement

Foreign Language Requirements

Students must have completed 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable [1]	4
ENGE 1215	Foundations of Engineering	2
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable [1]	4
MATH 2114	Introduction to Linear Algebra [1]	3
ENGE 1216	Foundations of Engineering	2
PHYS 2305	Foundations of Physics (w/lab)	4
	Credits	**16**
Second Year		
Fall Semester		
ESM 2104	Statics	3
ISE 2214	Manufacturing Processes Laboratory	1
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2306	Foundations of Physics (w/lab)	4
MSE 2034	Elements of Materials Engineering	3
ME 2004	Engineering Analysis Using Numerical Methods	3
	Credits	**17**
Spring Semester		
ECE 2054	Applied Electrical Theory	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
ME 2134	Thermodynamics	4
	Credits	**16**
Third Year		
Fall Semester		
STAT 3704	Statistics for Engineering Applications	2
ME 3024	Engineering Design and Economics	3
ME 3414	Fluid Dynamics (w lab)	4
ME 3524	Mechanical Vibrations	4
ME 3624	Mechanical Design (w lab)	4
	Credits	**17**
Spring Semester		
ECE 3254	Industrial Electronics	3
ME 3304	Heat and Mass Transfer	3
ME 3534	Controls Engineering I (w lab)	4
ME 4005	Mechanical Engineering Lab	3
CS 1044	Introduction to Programming in C	3
ME 3034	Mechanical Engineering Discourse	1
	Credits	**17**
Fourth Year		
Fall Semester		
ME 4015	Engineering Design and Project	3
ME 4524	Introduction to Robotics and Automation	3
ME 4744	Mechatronics: Theory and Application	4
ME 4584	Robotics Laboratory	1
ME 4734	Robotics and Mechatronics Seminar	1
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**15**
Spring Semester		
ME 4016	Engineering Design and Project	3
Technical Elective		3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
Select three credits in Pathways 2, 3, 6A, or 7 [2]		3
	Credits	**15**
	Total Credits	**129**

1. Consult Timetable of Classes or University Course Catalog for minimum required prerequisite grade in MATH1225 to proceed to other MATH courses such as MATH1226 and MATH2114.
2. If enrolling in a Pathways Concept 7 elective, choose one that also covers either Concept 2 or 3 to avoid taking 3 additional credits to meet graduation requirements.

Mining and Minerals Engineering

Our Website (http://www.mining.vt.edu)

Overview

The Department of Mining and Minerals Engineering offers an engineering program containing aspects of mineral science, engineering, and technology that is professionally related to the minerals industry. Graduates of this program find domestic and international employment opportunities with hardrock, coal, industrial minerals, and construction aggregates producers, as well as with government agencies and equipment vendors.

The mission of the department is to produce high quality, rigorously trained mining engineers, whose background and education reflect the current level of technology and thought of the profession, and who can enter directly into engineering practice or, alternatively, graduate school for further study.

Accreditation, Program Educational Objectives, and Student Outcomes

The B.S. degree program in Mining Engineering is accredited by the Engineering Accreditation Commission of ABET, www.abet.org (http://www.abet.org), under the commission's General Criteria and the Program Criteria for Mining and Similarly Named Engineering Programs.

The Department of Mining and Minerals Engineering seeks, as its **Program Educational Objectives**, to prepare alumni within a few years of graduation to possess:

- the intellectual ability to critically assess and tackle any engineering problem they may encounter;
- the communication skills to communicate technical information to a variety of audiences including technically trained supervisors and subordinates as well as non-technical members of the work force and the general public;
- the leadership and team building skills to lead projects and function as entry-level managers as well as work productively as members of a team;

- an understanding of the practical aspects of the mining industry and an appreciation for mining as a business; and
- an awareness of societal issues and how these issues affect their role as future professional engineers working for the general benefit of society.

Upon the time students complete the BS in Mining Engineering degree, the **Student Outcomes** that each graduate should have are:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Curriculum

The mining engineering curriculum utilizes the basic and engineering sciences to develop the various areas of activity of the mining engineer: mineral exploration, evaluation, development, extraction, mineral processing, conservation, protection of the environment, and mineral economics. Course work in these areas provides a unique background for engineering and management positions in industry and government, as well as for continuation of specialized graduate studies.

Intrinsic to the curriculum is the development of a meaningful, major engineering design experience that builds upon the fundamental concepts of mathematics, basic sciences, the humanities and social sciences, engineering topics, and communication skills. This design experience is stressed within the major and grows with the development and progression of the student. Ethical, social, safety, economic, and environmental considerations are emphasized in the design experience throughout many courses, including the capstone senior design course. Finally, the major engineering design experience is a focal point of the mining engineering curriculum and is consistent with the objectives and goals of the program.

The program has an emphasis on the application of computers to mining and minerals processing operations. Furthermore, it exposes students to laboratory courses which focus on conducting experiments, understanding the principles involved in each experiment, and analyzing and interpreting experimental data. Information on the mission, goals, and curriculum of the program is continuously updated on the departmental website.

The Cooperative Education Program, as well as opportunities for financial support in the form of scholarships, loans, awards, and summer employment, are available to undergraduate and graduate students. Graduate programs are available leading to the M.S., M. Eng., and Ph.D.

- Mining Engineering Major (p. 937)

Head: A. Noble
University Distinguished Professor and Nicholas T. Camicia
Professor: R.H. Yoon
Stonie Barker Professor: E.A. Sarver
Professor: E.C. Westman and A. Noble
Associate Professors: B. Nojabaei, N. Ripepi, E.A. Sarver, and W. Zhang
Assistant Professors: R. Pandey
Professor of Practice: R. Bishop
Affiliated Faculty: R. Pollyea

Undergraduate Course Descriptions (MINE)

MINE 1024 - Leadership and Service in the Mineral Industries (1 credit)
Leadership and service principles. Awareness of self and others through personality typing. Strategic planning. Importance of energy and mineral industries to developed and developing countries as well as associated consequences. Mineral extraction and purification processes and calculations. Conflict resolution. Challenges and opportunities available in the energy and mineral industries. May include guest speakers and field trips.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1034 - Automation and Data Analytics in the Mineral Industries (1 credit)
Discovering challenges and opportunities available in autonomous vehicles, systems, and data analytics associated with the energy and mineral industries. Fundamentals of robotics and data analytics; hands on projects with autonomous kits and drones; analysis of industry data, including production studies; introduction to presentation of complex data in a simplified manner; introduction to simulations and digital twins.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1044 - Space Mining (1 credit)
Explore challenges and opportunities in off-earth mining. Resources currently identified on earth and critical uses; astroidal, lunar, and martian resources; operating conditions in space; environmental, social, and governance issues; economic drivers; in situ resource utilization.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2114 - Energy and Raw Materials: Geopolitics and Sustainable Development (3 credits)
Supply and demand of energy resources and raw materials. Domestic and global trends. Development of energy and mineral resources. Electricity generation, efficiency, and distribution. Energy and raw materials infrastructure Disparities in resource-producing vs. resource-consuming regions. Environmental considerations and engineering management. Land use and reclamation. Greenhouse gas management. Policy, regulations, and incentives. Geopolitical considerations. Conservation and efficiency. Sustainable development. This course is available to undergraduate students of all ranks and all majors.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2504 - Introduction to Mining Engineering (3 credits)
Introduction to the complete field of mining and minerals engineering, including phases of mine development, discreet mining methods and mineral processing operations. Consideration in unconventional oil and gas development. Emphasis on basic engineering problem solving skills, and considerations for worker health and safety, economics, and environmental and social issues.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2524 - Elements of Mine Design (3 credits)
Basic concepts used in the modeling and design of mining systems including basic statistical concepts, sampling, geological and geostatistical modeling of ore bodies, ore reserve estimation, and selection of basic mine development methods.
Prerequisite(s): MINE 2504 and GEOS 1004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2534 - Mine Surveying and Mapping (3 credits)
Specialized principles of field surveying and mapping as applied to the delineation of mineral deposits and the design and monitoring of surface and underground mining operations. Introduction to modern surveying instruments, field techniques, and computational procedures. Basic digital mine mapping to include standard mine symbols and representation of surface and underground mine workings. Partially duplicates ENGE 2824.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2544 - Leadership for Responsible Mining (2 credits)
Principles of leadership for the global resource industries including identification of project impacts and risks, stakeholder analysis and conflict management. Emphasis on engineering ethics and effective communications. Sustainable development of mineral and energy resources, with focus on emerging technical, economic, environmental and social issues in the US and abroad.
Prerequisite(s): ENGL 1106
Corequisite(s): MINE 2504
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 2564 - Resource Exploration and Design (3 credits)
Basic methods and concepts in exploration and modeling of ore bodies. Resource exploration planning. Exploration technologies for potential mine sites. Design of mining systems. Computational modeling of ore bodies and mine systems. Environmental, regulatory, ethical, and social considerations in mine system design.
Prerequisite(s): GEOS 1004
Corequisite(s): MINE 2504
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 2714 - Introduction to Petroleum and Natural Gas Engineering (3 credits)
Introduction to basics of petroleum and natural gas engineering. Concepts of conventional and unconventional fossil fuel energy; basics of rock mechanics and reservoir fluid properties. Concepts of drilling and completion engineering. Concepts of hydraulic fracturing; basic knowledge of formation evaluation and various rock types. Basics of geophysical monitoring methods; basics of different oil and gas reservoirs; basics of production engineering and fundamentals of recovery mechanisms, discussion of petroleum and natural gas social and policy issues.
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 3544 - Mineral Processing Laboratory (1 credit)
Laboratory investigations of the unit operations and principles of mineral processing including ore preparation (size reduction, mineral liberation, and classification) and mineral recovery (froth flotation, electrostatic separation, magnetic separation, and solid-liquid separation).
Prerequisite(s): MINE 3534
Corequisite(s): MINE 3554
Instructional Contact Hours: (3 Lab, 1 Crd)

MINE 3564 - Underground Mine Design (3 credits)
Design fundamentals of mining systems and stope development for tabular and massive underground mineral deposits. Equipment selection and application, permitting, cost analysis and production simulation.
Prerequisite(s): MINE 2564 and MINE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3574 - Surface Mine and Quarry Design (3 credits)
Surface mining methods, and their selection; mine planning and design; excavation, haulage and ancillary systems; equipment selection and maintenance; impoundment and piles design; mine closure/reclamation.
Prerequisite(s): MINE 2564 and MINE 3674
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3584 - Ventilation Engineering (3 credits)
Subsurface ventilation systems. Ventilation planning and design, laws of airflow, airway resistance. Ventilation surveys, network analysis, ventilation economics. Ventilation software. Fan types, impeller theory, fan laws and testing. Mine ventilation thermodynamics.
Prerequisite(s): MINE 2504
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3604 - Mining Geomechanics (3 credits)
Properties and behavior of geologic materials and masses and their classifications and ratings. Design principles of structures founded on and in rocks and basic aspects of ground control in mining. Laboratory techniques used in the determination of geologic materials properties and behavior. Determination of rock index properties, strengths, failure criterion and mechanical behavior.
Prerequisite(s): MINE 2504 and GEOS 1004 and ESM 2204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3624 - Mineral Resource Project Management (3 credits)
Applied and theoretical concepts in the valuation and management of mining and energy extraction projects. Project engineering, resource management, scheduling, and tracking. Estimation of capital costs, operating costs, and revenues for underground and surface mines, mineral beneficiation plants, and oil and gas ventures. Commodity sales contracts and price projections. Cash flow analysis, revenue-generating and service producing alternative selection, taxes/deductions. Quantitative risk analysis including stochastic simulation. Environmental, ethical, and legal considerations in project management.
Prerequisite(s): MINE 2504 and MINE 2564
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3634 - Fundamentals of Mineral Processing (3 credits)
Principles of mineral processing with an emphasis on metallurgical data evaluation, unit operations, and flowsheet configurations. Metallurgical accounting, slurry calculations, grade-recovery relationships, chemical aspects of mineral processing, and particle size analysis. Unit operations including rushing, grinding, size separation, gravity separation, magnetic and electrostatic separation, froth dewatering. Laboratory investigations of the unit operations and principles of mineral processing.
Prerequisite(s): MINE 2504 and GEOS 1004 and CHEM 1035
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

MINE 3644 - Applications in Mineral Processing (2 credits)
Applied concepts in the design and operation of mineral processing plants. Flowsheet engineering, unit selection, unit sizing, water/mass flow balancing, simulation, process control, and cost estimation. Environmental, economic, and legal considerations in process plant design.
Prerequisite(s): MINE 3634
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 3664 - Fluids and Thermodynamics for Resources (3 credits)
Fluid properties and hydrostatics. Derivation and application of the continuity, momentum, and energy equation (Bernoulli's equation) for ideal and real fluid flow (laminar or turbulent). Properties of pure substances: property tables, property software, equations of state. First law of thermodynamics. Second law of thermodynamics. Gas mixtures. Applications in the resource extraction industries.
Prerequisite(s): ESM 2304 and MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3674 - Explosives and Rock Fragmentation (3 credits)
Rock fragmentation for excavation; drilling fragmentation, rock drilling systems; blasting fragmentation, types and properties of commercial explosives and accessories, system of initiation, design of blasting rounds, applications in mining and construction, structural damage criteria, overbreak control, safe practice and regulations; fragmentation by excavation machines; excavation system selection and design.
Prerequisite(s): MINE 2504 and GEOS 1004 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3714 - Petroleum and Natural Gas Reservoir Engineering (3 credits)
Introduction to oil and gas reservoirs; basics of reservoir rock and fluid properties; fundamentals of different petroleum reservoirs; determination of oil and gas in place; material balance equation; prediction of transient pressure distribution; prediction of saturation distribution; basics of recovery mechanisms; single and multiphase flows in petroleum reservoirs; and prediction of recovery factor and production rate.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3724 - Formation Evaluation and Engineering (3 credits)
Well log measurements and interpretation; standard logging suites used in industry; core sampling methods and laboratory analysis; relationship of well data to seismic and other geophysical data; relationship of well-derived reservoir properties to reservoir estimation calculations, well completions strategies, and development strategies.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4504 - Materials Handling and Power Systems (3 credits)
Principles of materials handling, fluid power and electrical power systems for surface and underground mining operations. Engineering analysis and design of secondary haulage operations (belt conveyors, hoists, trucks, railways), fluid power systems (hydraulics, pumps, piping networks, compressors, pneumatic equipment). Electrical systems (electrical machinery, distribution networks, controls), and other ancillary systems required to support mining operations. Assessment of equipment reliability and development of preventive maintenance programs.
Prerequisite(s): ESM 3024
Corequisite(s): ECE 3054
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4614 - Health and Safety Systems (3 credits)
Investigation of health and safety management systems. Study of mine legislation; data analysis of accidents; hazard identification; risk management; training programs; emergency response plans.
Prerequisite(s): MINE 3564 or MINE 3574
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4624 - Mine and Water Reservoir Engineering (3 credits)
Essential topics related to water in resource extraction projects, including surface and ground water hydrology, chemistry and treatment of mine-influenced waters and waters from unconventional oil and gas production, and mine dewatering. Emphasis on basic design calculations and modeling.
Prerequisite(s): MINE 3664 and (MINE 3564 or MINE 3574)
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4635 - Mining Engineering Capstone (2 credits)
4635: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. 4636: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. Culminates in the preparation of a technical report that describes the commercial development, extraction and closure of a mineral deposit under global reporting standards, and provides detailed operational layouts, production calculations, and engineering cost analyses.
Prerequisite(s): MINE 2544 and (MINE 3564 or MINE 3574) and MINE 3624
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4636 - Mining Engineering Capstone (2 credits)
4635: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. 4636: Serves as the capstone design course sequence for Mining and Minerals Engineering. Undertake a comprehensive design project and feasibility study that integrates courses taken throughout their curriculum, in consideration of public and occupational health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors and constraints. Includes exploration of professional and ethical obligations of engineers and impacts of projects on communities, project management, communication, and working in teams. Culminates in the preparation of a technical report that describes the commercial development, extraction and closure of a mineral deposit under global reporting standards, and provides detailed operational layouts, production calculations, and engineering cost analyses.
Prerequisite(s): MINE 4635
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4644 - Environmental Management for Mining and Geoenergy (2 credits)
Environmental impacts of mines and geoenergy resource development projects, including water, land and air pollution. Statutory and regulatory environmental requirements, with an emphasis on permitting, monitoring and compliance. Best practices for environmental management systems.
Prerequisite(s): MINE 3564 or MINE 3574
Instructional Contact Hours: (2 Lec, 2 Crd)

MINE 4654 - Mine Power Systems and Automation (3 credits)
Fundamentals of electrical theory. Circuit elements, calculations and network analysis. Components and design of mine power systems. Motors, cables, load flow analyses, transmission and distribution. Electrical safety. U.S. mine-specific regulation, intrinsic safety and permissibility. Applications in mine systems automation via programmable logic control. Basic ladder logic routines.
Prerequisite(s): MATH 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4664 - Resource Engineering Leadership Seminar (1 credit)
Invited speakers and subject experts, assigned readings, facilitated activities and discussions, personality and values assessment, learning taxonomy and learning styles, diversity in the workplace, implications of personal differences for workplace and leadership dynamics, strategies and best practices for effective leadership, oral and written communication for diverse audiences. Pre: Senior Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

MINE 4714 - Well Drilling and Completion Engineering (3 credits)
Introduction to drilling and completion design; functions of drilling fluids; wellbore hydraulics and drilling bits; principles of well control; casing design; design of cementing jobs; directional drilling in conventional and unconventional formations, completions.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4724 - Petroleum and Natural Gas Production Engineering (3 credits)
Extraction of reservoir fluids; oil and gas thermodynamic properties; phase behavior of petroleum fluids; analysis of surface production facilities; fluid separation; processing of reservoirs fluids; fluid disposal in an environmentally acceptable manner; surface transportation systems; separator design; design of artificial lift systems.
Prerequisite(s): MINE 2714
Instructional Contact Hours: (3 Lec, 3 Crd)

MINE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MINE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Mining Engineering Major

Code	Title	Credits
Degree Core Requirements		
MINE 2504	Introduction to Mining Engineering	3
MINE 2564	Resource Exploration and Design	3
MINE 3604	Mining Geomechanics	3
MINE 3624	Mineral Resource Project Management	3
MINE 3564	Underground Mine Design	3
MINE 3574	Surface Mine and Quarry Design	3
MINE 4614	Health and Safety Systems	3
MINE 4644	Environmental Management for Mining and Geoenergy	2
Subtotal		23
Additional Course Requirements		
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
GEOS 1104	Introduction to Earth Sciences Laboratory	1
GEOS 3404	Elements of Structural Geology	3
or GEOS 4824	Engineering Geology	
GEOS 4624	Mineral Deposits	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MINE 2534	Mine Surveying and Mapping	3
MINE 3634	Fundamentals of Mineral Processing	3
MINE 3664	Fluids and Thermodynamics for Resources	3
MINE 3674	Explosives and Rock Fragmentation	3
MINE 3644	Applications in Mineral Processing	2
MINE 3584	Ventilation Engineering	3
MINE 4624	Mine and Water Reservoir Engineering	3
MINE 4654	Mine Power Systems and Automation	3
MINE 4664	Resource Engineering Leadership Seminar	1
Elective Courses		
Technical Electives		6
Subtotal		55
Pathways to General Education		

Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
MINE 2544	Leadership for Responsible Mining (1A)	2
MINE 4635	Mining Engineering Capstone (1A)	2
MINE 4636	Mining Engineering Capstone (1A)	2
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
PHYS 2305	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216 or ENGE 1414	Foundations of Engineering and Foundations of Engineering (C-) Foundations of Engineering Practice	4
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways 7 should be double counted with either Pathways 2, 3 or 6a to avoid taking any additional credit hours.		3
Subtotal		50
Total Credits		**128**

Technical Electives

Courses with substantial duplication of courses taken previously will not qualify for credit. MINE 4974 Independent Study and MINE 4994 Undergraduate Research may not be used as electives. Additional technical electives may be used as a substituted course through a 4984 or 5984 course with the review and approval from the department head.

Choose from the courses listed below, noting that some courses are not available to all students because they may have prerequisites or be restricted to majors in the offering department.

Code	Title	Credits
BSE 4394	Water Supply and Sanitation in Developing Countries	3
CEE 3104	Introduction to Environmental Engineering	3
CEE 4264	Sustainable Land Development	3
CEE 4144	Air Resources Engineering	3
CEE 3514	Introduction to Geotechnical Engineering	4
CEE 4514	Methods in Geotechnical Engineering	3
ECON 4014	Environmental Economics	3
ENSC 3634	Physics of Pollution	3
CSES 4644	Land-based Systems for Waste Treatment	3
ENSC 4774	Reclamation of Drastically Disturbed Lands	3
FIN 3104	Introduction to Finance	3
FIN 3134	Financial Analytics	3
FIN 3144	Investments: Debt, Equity and Derivatives	3
FIN 3154	Corporate Financial Analytics and Strategy	3
FIN 4144	International Financial Management	3
FIN 4214	Financial Modeling in Excel	3
FREC 4014	Natural Resources Economics	3
GEOG 4354	Introduction to Remote Sensing	3
GEOS 3014	Environmental Geosciences	3
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3504	Mineralogy	3
GEOS 3614	Soils	3
GEOS 4164	Potential Field Methods in Exploration Geophysics	4
GEOS 4404	Advanced Structural Geology	3
GEOS 4634	Environmental Geochemistry	3
GEOS 4804	Groundwater Hydrology	3
ISE 4004	Theory of Organization	3
ISE 4654	Principles of Industrial Hygiene	3
MGT 3304	Management Theory and Leadership Practice	3
MGT 4314	International Management	3
MINE 2714	Introduction to Petroleum and Natural Gas Engineering	3
MINE 3714	Petroleum and Natural Gas Reservoir Engineering	3
MINE 3724	Formation Evaluation and Engineering	3
MINE 4714	Well Drilling and Completion Engineering	3
MINE 4724	Petroleum and Natural Gas Production Engineering	3
MSE 3304	Physical Metallurgy	3
PSYC 3024	Human Behaviors and Natural Environments	3
PSYC 3054	Health Psychology	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4264	Environmental Ethics and Policy	3
UAP 4374	Land Use and Environment: Planning and Policy	3

1. Each student must meet the minimum University wide criteria as described for satisfactory progress and summarized in the Undergraduate Catalog (under Academic Policies -> University Policies Governing Enrollment -> Satisfactory Progress). After having completed 72 credit hours (including transfer, advanced placement, advanced standing, and credit by examination) a student must:
2. Maintain an overall and in major GPA of 2.0 or better. (In-major GPA is calculated using all courses taken under the MINE designator)
3. Have passing grades in MINE 2504 Introduction to Mining Engineering, MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations.

Graduation Requirements

Each student must complete at least 128 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. In-major GPA is determined from all courses with MINE designator.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
2. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra, MATH 2204 Introduction to Multivariable Calculus, and MATH 2214 Introduction to Differential Equations

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
ENGL 1105	First-Year Writing	3
ENGE 1215	Foundations of Engineering	2
MATH 1225	Calculus of a Single Variable (C-)	4
Pathways Concept 2, 3, 6a, or 7		3
	Credits	**16**
Spring Semester		
ENGE 1216	Foundations of Engineering	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable	4
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics	4
Pathways Concept 2, 3, 6a, or 7		3
	Credits	**19**
Second Year		
Fall Semester		
ESM 2104	Statics	3
GEOS 1004	Earth Science: Our Past, Present, and Future	3
GEOS 1104	Introduction to Earth Sciences Laboratory	1
MATH 2204	Introduction to Multivariable Calculus	3
MINE 2504	Introduction to Mining Engineering	3
MINE 2534	Mine Surveying and Mapping	3
	Credits	**16**
Spring Semester		
ESM 2204	Mechanics of Deformable Bodies	3
ESM 2304	Dynamics	3
MATH 2214	Introduction to Differential Equations	3
MINE 2544	Leadership for Responsible Mining	2
MINE 2564	Resource Exploration and Design	3
Pathways Concept 2, 3, 6a, or 7		3
	Credits	**17**
Third Year		
Fall Semester		
MINE 3604	Mining Geomechanics	3
MINE 3624	Mineral Resource Project Management	3
MINE 3634	Fundamentals of Mineral Processing	3
MINE 3664	Fluids and Thermodynamics for Resources	3
MINE 3674	Explosives and Rock Fragmentation	3
	Credits	**15**
Spring Semester		
GEOS 3404 or GEOS 4824	Elements of Structural Geology or Engineering Geology	3
MINE 3564	Underground Mine Design	3
MINE 3574	Surface Mine and Quarry Design	3
MINE 3584	Ventilation Engineering	3
MINE 3644	Applications in Mineral Processing	2
Pathways Concept 2, 3, 6a, or 7		3
	Credits	**17**
Fourth Year		
Fall Semester		
MINE 4614	Health and Safety Systems	3
MINE 4624	Mine and Water Reservoir Engineering	3
MINE 4635	Mining Engineering Capstone	2
MINE 4654	Mine Power Systems and Automation	3
MINE 4664	Resource Engineering Leadership Seminar	1
Technical Elective		3
	Credits	**15**
Spring Semester		
GEOS 4624	Mineral Deposits	3
MINE 4636	Mining Engineering Capstone	2
MINE 4644	Environmental Management for Mining and Geoenergy	2
Technical Elective		3
Pathways Concept 2, 3, 6a, or 7		3
	Credits	**13**
	Total Credits	**128**

Myers-Lawson School of Construction (Construction Engineering and Management Program)

Our Website (http://cem.mlsoc.vt.edu/)

Overview

The Myers-Lawson School of Construction offers students in the College of Engineering a Bachelor of Science Degree in Construction Engineering and Management. This degree is designed for students who wish to pursue a management or engineering career in the construction industry. The undergraduate program facilitates the development of critical technical, managerial and professional knowledge and skills required for entry into the construction industry or graduate studies. This body of knowledge includes the decision and optimization methods required to integrate and manage the resources essential to construction operations along with the skills that support the development of safe, ethical, socially responsible, and sustainable solutions for the built environment.

Construction managers plan, direct, and coordinate construction projects, including the building of all types of residential, commercial, and industrial structures, roads, bridges, and other public works projects. Construction managers coordinate and supervise the construction process from the conceptual development stage through final construction, ensuring the project is completed within time and budget constraints and is compliant with building and safety codes and other regulations.

The focus of this degree is construction management with engineering and business management as additional focus areas of study. The degree

retains an emphasis on engineering, with a focus on construction theory and applications, while providing students the opportunity to define the areas of business management they wish to study to complement their career goals. The program offers majors in Construction Engineering and Management and Construction Safety Leadership.

Coursework (CEM xxxx) focuses on the specific knowledge, skills and abilities (KSA) critical for successful Construction Engineering and Management. Additional coursework is leveraged from the Via Department of Civil and Environmental Engineering, and the Department of Building Construction. The latter department is also in the School.

Classroom instruction in the construction engineering and management program is reinforced by instructional laboratories, field trips and guest lectures by leading construction professionals. The program seeks to employ the latest educational technology and innovative teaching methods.

Students in the School have the opportunity to participate in a summer internship program during which they may apply the concepts learned in the classroom in real world applications. The School encourages all students to participate in professional work experience prior to graduation, and all students are encouraged to pursue their FE and PE licenses.

Accreditation

The Construction Engineering and Management Program is accredited by the Engineering Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Construction and Similarly Named Engineering Programs and is also accredited by the Applied and Natural Science Accreditation Commission of ABET, https://www.abet.org (https://www.abet.org/), under the commission's General Criteria and the Program Criteria for Construction and Similarly Named Engineering Programs.

Program Educational Objectives

The Program Educational Objectives of the Construction Engineering and Management program are that, within a few years of program completion, graduates should be effectively serving society as construction engineering and management professionals by:

- Identifying, designing, analyzing, integrating, and managing the technical, material, financial, legal, and personnel administration aspects that support construction operations, projects and organizations throughout the project lifecycle, i.e., from programming to decommissioning.
- Incorporate safety, efficiency, cost effectiveness, environmental sensitivity and social awareness into the development, planning and implementation of construction operations and processes.
- Apply skills of effective communication, entrepreneurship, teamwork, values-based leadership, professional and ethical behaviors that are the necessary complement to technical competence.
- Continue their professional development and learning which may include professional licensure or certification, graduate level education, continuing education courses, self-directed study and active involvement in the construction community.

Student Outcomes

The Student Outcomes defined knowledge, skills and abilities which a student should attain upon completion of the BS in Construction Engineering and Management degree. The Construction Engineering and Management Program has student outcomes that correspond to requirements for its accreditation under the Engineering Accreditation Commission (EAC) of ABET and the Applied and Natural Science Accreditation Commission (ANSAC) of ABET (as noted in parentheses below). The outcomes are that, by the time of their degree completion, students should have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. an ability to communicate effectively with a range of audiences.
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Class Size

Our goal is to keep the average class size for all CEM courses low, around 40 students per section. Our average entering class size each fall semester is around 60 students. We want to encourage students to get to know each other and their faculty and to provide opportunities for engagement with one another. Creating a warm, inviting, inclusive, and engaging community is a part of our culture in CEM.

Program Contact

he contact person for the undergraduate Construction Engineering and Management program is the CEM Program Chair Ashley Johnson. Ashley can be reached at alj@vt.edu.

- Construction Engineering and Management Major (p. 951)
- Construction Safety Leadership Major (https://catalog.vt.edu/undergraduate/college-engineering/construction-engineering-management/construction-safety-leadership-bs/)

Director: Brian Kleiner
Program Coordinator: Ashley Johnson
Principle Faculty: K. Afsari, A. Akanmu, X. Gao, L. Franklin, J. Iorio, A. Johnson, B. Kleiner, L. Lally, C. Smith

Undergraduate Course Descriptions (BC)

BC 1014 - Building A Strong Foundation for Success (2 credits)
Exploration of career options within the built environment and construction industry. Professional development, digital literacy, which will include creation of media and "personal brand" identity. Exploration of ideas from multiple viewpoints and perspectives. Oral, written, and visual presentation of ideas such as resume development. Introduction to ethical considerations. Reflection on "Self-as-Learner." Critical-Thinking skills as they apply to construction projects. Development of group roles as they apply to construction projects. Identification of universities resources, policies, procedures, academic and social engagement opportunities.
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 1114 - Introduction to Building Construction (3 credits)
Introduction to construction with understanding of different market sectors, specializations, career path opportunities, industry stakeholders, and processes. Comprehension of quality assurance, control, project delivery systems, basic estimating, and scheduling. Application of communication skills to professional settings and use of basic calculations to solve construction math problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 1124 - Construction Documents and Safety (2 credits)
Role of construction drawings and specifications. Interpretation of construction documents and creation of basic project documentation. Health, safety, and environmental hazards encountered in the construction industry. Design Lab Studio (1H, 2L, 2C)
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

BC 1214 - Introduction to Building Construction I (3 credits)
Introduction to construction with an overview of construction drawings and specifications, construction terminology, building codes and building systems, cost estimating and bidding, construction management processes, construction documents, load paths and foundations, construction health and safety, and hands-on experiential learning through lab exercises. Strategic career success factors and introduction to ethical decisions in construction management.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 1224 - Introduction to Building Construction II (3 credits)
Overview of the important areas of contracting and the workings of the construction industry. Application of construction management theory, processes, and terminology including, definable building systems, building code interpretations, the reading and preparing of basic construction drawings and integrating construction details and project specifications to derive safe construction means and methods, equipment section, cost estimates and time schedules.
Prerequisite(s): BC 1214 or BC 1114
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2004 - Construction Surveying (1 credit)
Surveying in context of the construction process, basic surveying methods, equipment, emerging technologies, topographic surveying, and application to construction layout.
Prerequisite(s): BC 1124
Instructional Contact Hours: (1 Lec, 1 Crd)

BC 2014 - Construction Principles I (3 credits)
Fundamentals of the construction technology and process emphasizing project management/operations, materials and methods. Utilization of industry-specific technology/software applications, techniques and sequences/project loading for the construction of buildings in compliance with Construction Specifications Institute (CSI) Divisions 00-05, 31, 32, 33. Planning, scheduling, materials cost analysis, job-appropriate equipment and labor requirements, masonry applications, concrete and formwork. Site preparation and utilization, use of construction industry-specific software, interpretation of project drawing documents. Integration of project safety and health issues. Quantity surveying for the management of construction resources, according to current principles and industry standards.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2024 - Construction Principles II (3 credits)
Continuation of the fundamentals of construction technology and process emphasizing materials, methods, techniques and sequences for the construction of buildings using Construction Specifications Institute (CSI) Divisions 01, 06-14, 21. Interpretation of construction details relevant to a construction project. Cost impact of building codes and inspections. Development of presentation skills using project-based learning. Planning, scheduling, labor needs, and quantity surveying for the management of construction resources. Development of safety and quality assurance plans, including building systems for fire suppression.
Prerequisite(s): BC 2014
Corequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2044 - Construction Materials (3 credits)
Introduction to the life cycle, properties, behaviors, and sustainability impacts of common construction materials including wood, insulation, asphalt, ferrous and nonferrous metals, aggregate, concrete, masonry, glass, and plastics. Theory of materials including material properties; behavior under physical, thermal, and environmental loads; and interfaces between dissimilar materials. Methods and criteria for material comparison and selection for sustainable construction. Preparation of professional written reports as a team and individually; Project management for materials selection/application.
Corequisite(s): BC 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 2064 - Integrated Construction I (3 credits)
Application of construction means, materials and methods related to quantity take-off, cost management, scheduling, resource management, document drawing, building information modeling in support of a selected project. Project cost impact of building code requirements. Emphasis on structural components of selected project.
Prerequisite(s): BC 2014 and BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2104 - Building Effective Construction Teams (3 credits)
Introduction to leadership behavior styles and their impact on construction management team performance, including analysis of how ethical behavior and individual strengths support positive relationship-building. Development of management strategies to maximize positive conflict outcomes through trust-building between construction project stakeholders. Identification of the role that implicit bias plays in decision-making within diverse project teams. Development of presentation skills for a construction audience.
Prerequisite(s): BC 1224 or BC 1124
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2114 - Information Technology in Design and Construction (3 credits)
Building delivery and project management improvements through the use of information technology (IT) are explored, including scheduling software, building information modeling (BIM) tools, and virtual design and construction (VDC) simulation software and their corresponding theories and concepts that integrate design and construction. Use BIM/VDC tools for graphical presentations, databases, and spreadsheets.
Prerequisite(s): BC 1224 or CEM 2104 or BC 1124
Corequisite(s): BC 2014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2134 - Construction Data Analysis (2 credits)
Identification and use of various types and sources of construction market data and the tools for analyzing construction data to support managerial decision making. Different forms of applying mathematics to the construction market for better productivity and processes across the construction industry. Develop insights to inform management and investment decisions. Use of cost-benefit analysis as applied to construction management in determining feasibility of projects.
Prerequisite(s): MATH 1025 or MATH 1225
Instructional Contact Hours: (2 Lec, 2 Crd)

BC 2214 - Why Buildings Stand Up (3 credits)
Overview of fundamental principles explaining why structures remain stable under various loading conditions. Explores different types of structures and applied loads and analyzes both determinate and indeterminately supported structures. Calculation of shear, bending moments, deflections in beams, and buckling. Discussion of ethical impacts on user safety and hazard avoidance, in project design and construction methods, materials, etc. Explores different types of soil composition and their strength properties.
Prerequisite(s): (BC 1224 or BC 1124) and (MATH 1025 or MATH 1225)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2354 - Residential Construction Technologies (3 credits)
Identify and evaluate conventional construction materials, methods, building systems, and products to less-familiar, innovative technological alternatives for a specific residential construction project. Compare innovative technological alternatives with material and cost estimates. Overview of conventional materials, equipment, designs, and processes in residential construction. Investigate recent literature on emerging technologies to determine best practices. Strengthen understanding of the primary building systems in residential construction applications.
Prerequisite(s): BC 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 3014 - Building Physics and Environmental Systems (3 credits)
Theory and analysis methods relative to performance of envelope systems and the design and integration of mechanical and electrical building systems. Topics covered include: envelope systems and performance metrics, conceptual and technical design theory, operational principles, and maintenance issues, all necessary for determining the selection of passive and active environmental control systems within a building including: envelope system, heating, ventilation, air conditioning, lighting, and acoustical systems.
Prerequisite(s): PHYS 2205 and PHYS 2215 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3064 - Integrated Construction II (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on building systems components of selected project.
Prerequisite(s): (BC 2064 or CEM 2104) and (PHYS 2205 and PHYS 2215 or PHYS 2305)
Corequisite(s): BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 3114 - Building Systems Technology (3 credits)
Emphasis is placed on the integration and physical installation of passive and active environmental control systems including: heating, ventilation, air conditioning, lighting, acoustics, plumbing, and fundamentals of thermal loads.
Prerequisite(s): BC 2024 and (PHYS 2305 or PHYS 2205 and PHYS 2215) or (CEM 2104 and PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BC 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 3134

BC 3954 - Study Abroad (1-19 credits)
Study abroad in Spain.
Instructional Contact Hours: Variable credit course

BC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4024 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 4014

BC 4064 - Integrated Construction III (3 credits)
Application of construction means, materials and methods as they relate to quantity take-off, cost management, scheduling and resource management, document drawing, building information modeling in support of a selected project. Emphasis on administrative/general contractor functions (such as project safety, budget development, and permitting) of the selected project.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4114 - Building Information Modeling in Design and Construction (3 credits)
Introduction to means and methods to enrich the geometric information of a building model with semantic data such as, material, structural and performance values. Concept of interoperability in architecture, engineering and construction industry. Overview of approaches to information modeling such as Standard for the Exchange of Product model data (STEP), Industry Foundation Classes (ifc), Construction Operations Building Information Exchange (COBie) and Green Building XML (gbXML). Key concepts of object-oriented modeling and programming.
Prerequisite(s): BC 2114 or (ENGE 1215 and ENGE 1216)
Corequisite(s): CS 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4124 - Digital Construction & Manufacturing (3 credits)
Explore working principles, design projects, & experiment with construction digital information modeling, computer numerical control (CNC), and computer aided manufacturing (CAM) processes. Fundamentals of digital prototyping. Analysis of the industry tools such as 3D scanners, 3D printers, CNC manufacturing techniques, and others, used to provide familiarity with technologies & provide understanding of their benefits & limitations.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4164 - Production Planning and Process Design for Construction (3 credits)
The course deals with the planning and design of construction processes. Course topics include production systems, behavior of construction systems and workers, the relationships between subsystems in the construction process, queuing systems, process modeling and simulation. The major emphasis is on production and productivity. Production problems that typically occur in construction systems are discussed. The course also explores recent innovations in construction system design such as lean construction and agile construction.
Prerequisite(s): BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4264 - Fundamentals of Construction Management (6 credits)
Practical construction management methods within the built environment. Construction materials, document drawings, management activities, fundamentals of construction scheduling and planning. Quality, quantity, and cost of materials necessary to complete a construction project. Construction information technology tools. Partially duplicates BC 2014 and 2114. Pre: Junior Standing.
Instructional Contact Hours: (6 Lec, 6 Crd)

BC 4314 - Building Performance and Energy Management (3 credits)
Fundamentals of building performance mandates for the built environment. Practical means and methods for evaluating building performance metrics within integrated design including acoustic performance, visual performance, and indoor air quality and management. Specific focus on energy resources consumed by thermal, hygrothermal, lighting, and other environmental building systems. Assessment of building energy consumption and analysis of retrofit scenarios through performance evaluation over the entire building life cycle.
Prerequisite(s): BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4324 - Innovation in Residential Construction (3 credits)
Mechanisms of historical and current innovations in the residential construction industry. Theory and application within the realms of innovation, diffusion, technology, adoption, new product development, housing innovation literature, supply chain management, sustainability, information technology, commercialization, and housing policy. Innovation theories and applications to residential construction through the analysis and utilization of data-driven hypotheses typical to the industry.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4334 - Sustainable Building Performance Management (3 credits)
Introduction to means and methods for managing the sustainability of buildings and their performance over the life cycle. Best practices for sustainable projects in the areas of planning/development, site design, project management, energy and water conservation and green building assessment tools and methods; Leadership in Energy and Environmental Design (LEED) rating system; economic analysis of green building alternatives; and implementation planning.
Prerequisite(s): BC 3064 and BC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4364 - Lifecycle BIM for Facility Management (3 credits)
BIM (Building Information Modeling) concepts and tools that are critical for facility operation and maintenance. Identifying, capturing, analyzing, exporting and exchanging facility lifecycle data. Spreadsheet-based and BIM based facility management platforms. Case studies and real-life application for understanding mechanical, electrical, and plumbing systems from an owner or facility manager perspective. Workflow processes for data exchange.
Prerequisite(s): BC 2114 and BC 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4374 - Residential Housing and Land Development (3 credits)
Application of means, methods, and strategies for delivering single and multi-family residential housing in urban and suburban contexts. Project planning, including market analysis to determine highest and best use of an identified property, marketing and sales strategies, site and product design and procurement, infrastructure requirements, zoning and government agency regulations, financial analysis and feasibility study, financing strategies, and delivery control systems. Roles of developer and project team in preparing formal proposals for a housing development to be submitted for financing. Identification and application of interfaces with project stakeholders. Overview of contemporary topics such as green development and affordable housing.
Prerequisite(s): BC 2354 and BC 3064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4434 - Construction Practice I (3 credits)
Explores advanced business and management practices and applications to vertical construction projects. Topics include scope, planning and scheduling, assemblies estimating, cash flow controls. Creation of work breakdown structure, application of concepts of assemblies estimating and general conditions to interpret insurance and contract requires along with digital construction practices.
Prerequisite(s): BC 3064 and BC 3114 and BC 3134
Corequisite(s): BC 4064
Instructional Contact Hours: (3 Lec, 3 Crd)

BC 4444 - Construction Practice II (4 credits)
This course explores and applies the business and construction practices related to operation of a construction company to a capstone experience. Construction operation is examined as it relates to construction, financial and personnel management. Project management topics studied in this course are applied in the corequisite lab. This course is formally designated as a writing intensive course. Formal written and edited and oral presentations are presented and critiqued by the BC faculty team, the writing resource center, students and industry professionals.
Prerequisite(s): BC 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BC 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

BC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CEE)

CEE 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2804 - Introduction to Civil and Environmental Engineering (3 credits)
Overview of the specialty areas within the civil engineering profession, professional engineer licensing, and engineering ethics. Includes recognizing contemporary issues in civil engineering, civil engineering work in the surrounding community, and the impact of civil engineering solutions on society. Emphasizes successful personal business practices for civil engineering professionals, to include the fundamentals of effective oral, written, and visual communication skills for the Civil Engineer. Introduction to engineering library resources. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2814 - Geomatics (4 credits)
Introduction to data measurement issues in the civil and environmental engineering sub disciplines. Collection techniques, analysis, errors, statistical description and visualization. Spatial measurements such as leveling, distance and angles, mapping and topographic surveys, the Global Positioning System, LiDAR, terrain models, earthwork methods, construction surveying, coordinate systems, and Geographic Information Systems. Non-CEE students are exempt from the CEE 2834 corerequisite.
Prerequisite(s): ENGE 1216 or ENGE 1414
Corequisite(s): CEE 2834
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

CEE 2834 - Civil Engineering Drawings and Virtual Modeling (3 credits)
Introduction to the use of Computer-Aided Drafting, Building Information Modeling and Geographic Information Systems software. Interpretation of civil engineering drawings. Creation of civil engineering plans and two- and three- dimensional visualizations. Professional collaboration tools. Basemap creation. Basic analysis tools utilizing Geographic Information Systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3014 - Construction Management (3 credits)
Introduction to the fundamental elements involved in managing construction projects. Project lifecycle, delivery methods and contracts, equipment and labor productivity, scheduling, and cost estimating and control. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3104 - Introduction to Environmental Engineering (3 credits)
Overall view of environmental engineering with emphasis on hazardous waste management, water treatment, wastewater treatment, air pollution and its control, solid waste management, groundwater pollution and environmental regulations.
Prerequisite(s): CHEM 1035 and CHEM 1045 and (MATH 1026 or MATH 1206 or MATH 1206H or MATH 1226 or MATH 2016 or MATH 2024) and (PHYS 2305 or PHYS 2205)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3274 - Introduction to Land Development Design (3 credits)
An introduction to the land development design process including site selection and feasibility, environmental considerations, utility layout, grading, stormwater management and integrating planning with the design of infrastructure to support residential and commercial development.
Prerequisite(s): CEE 2814 and (CEE 2824 or CEE 2834)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3304 - Fluid Mechanics for Civil and Environmental Engineering (4 credits)
Introductory course in fluid mechanics. Includes concepts and measurements of fluid properties; computing hydrostatic and hydrodynamic forces on hydraulic structures; computing fluid pressures, discharges, and velocities; and determining energy losses in pipe flows. Course includes conducting hydraulic laboratory experiments and demonstrations, analyzing and interpreting collected data, and preparing technical laboratory reports. Emphasizes the fundamentals of effective interpersonal, written, and visual communication skills for technical civil engineering reports. Design Lab/Studio. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): ESM 2104 and CEE 2804
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3314 - Water Resources Engineering (4 credits)
Open channel flow; hydrology; hydraulic modeling; hydraulic machinery and structures; laboratory experiments and demonstrations. Design Lab/Studio.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3404 - Introduction to Structural Engineering (3 credits)
Introduction to structural engineering as an art and science and its fundamental tenets; description of structural systems, structural loads, and load paths; structural models, case studies of successful and unsuccessful structural designs; calculations of forces and deformation for simple determinate structures (trusses, beams and simple frames) and indeterminate structures using virtual work, use of stiffness methods in computer programs.
Prerequisite(s): ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3424 - Reinforced Concrete Structures I (3 credits)
Behavior and design of reinforced concrete members based on ultimate strength. Uncertainty, load and resistance factors. Load paths in framing systems. Beams, columns and slabs in flexure and shear. Deflections and crack control. Design of reinforced concrete members. Columns under axial forces, shear and flexure.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or BC 2044)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3434 - Design of Steel Structures I (4 credits)
Properties and behavior of structural steel. Design of steel members and connections using American Institute of Steel Construction specifications. Consideration of loads, structural safety, and serviceability. Design of members to resist tension, compression, and bending. Design of basic steel connections including tension connections, bearing plates, and base plates. Team-based design project to design a simple steel framed building. Design Lab/Studio.
Prerequisite(s): (CEE 3404 or BC 2214) and (CEE 3684 or ESM 3054 or BC 2044)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3514 - Introduction to Geotechnical Engineering (4 credits)
Introduction to soil as an engineering material for construction and infrastructure support. Geological processes, soil classification, phase relations, geostatic and applied stresses, permeability, seepage effects, settlement, and strength. Laboratory testing, interpretation, and presentation of results. Application of geotechnical principles to civil and environmental engineering problems. Design Lab/Studio.
Prerequisite(s): ESM 2204 and GEOS 2104
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3604 - Introduction to Transportation Engineering (3 credits)
Planning, design and operation of transportation systems with emphasis in multimodal transportation techniques and unified system engineering theories to analyze large scale transportation problems. Discussion of Intelligent Vehicle Highway Systems (IVHS) and hands on experience in computer models in transportation operations and planning. Interactions between transportation infrastructure and environmental engineering planning. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3684 - Civil Engineering Materials (4 credits)
Fundamental nature and performance of civil infrastructure materials, including metals, portland cement concrete, asphalt concrete, polymers, and wood. Material properties, microstructure, and mechanical behavior. Laboratory experimental procedures and standardized testing, property variability, durability, sustainability and resilience. Design of cementitious and asphalt mixtures, experimental design, non-destructive testing. Design lab/studio.
Prerequisite(s): CHEM 1045 and CHEM 1035 and ESM 2204 and GEOS 2104 and (CEE 2814 or CEM 2824)
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

CEE 3804 - Computer Applications for Civil and Environmental Engineers (3 credits)
Introduction to computer applications in civil and environmental engineering. Integration of quantitative analysis for design, data management, computer programming and problem solving skills with computer tools and techniques. Topics include systems analysis, numerical methods, optimization, data mining, computer programming and data queries. Analysis and interpretation of a global data set. Pre: Junior Standing.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3814 - Analytical Tools in Civil and Environmental Engineering (3 credits)
Computer programming and data analysis for civil and environmental engineering projects. Acquiring, cleaning and pre-processing data sets. Probability distributions, hypothesis testing, and regression modeling. Time series and frequency analysis. Data visualization.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CEE 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4014 - Estimating, Production, and Cost Engineering (3 credits)
Interpretation of plans and specifications, preparation of construction estimates, and cost control. Methods analysis, resource requirements, and resource costs in building systems, including system components, and in large-scale civil engineering works such as highways, bridges, and hydraulic structures.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 4024

CEE 4024 - Construction Control Techniques (3 credits)
Techniques used to plan, schedule, and control the Construction Process. Emphasizes manual and computer-based approaches. Focuses on an analytical approach towards the construction process whereby good technical methodologies and solutions are converted to reality through construction practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4034 - Smart Sustainable Infrastructure (3 credits)
Challenges and barriers to sustainable infrastructure. Effects of a changing planet and society on current infrastructure systems. Technology and data use for engineering. Infrastructure data interpretation. Data-driven engineering solutions.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4074 - Construction Engineering: Means and Methods (3 credits)
Construction means, methods, and equipment used to transform a particular design concept into a completed usable structure or facility. Selection and optimization of individual units as well as the systems needed to produce the required work to the required quality on time and on budget.
Prerequisite(s): CEE 3014 or CEM 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4104 - Water and Wastewater Treatment Design (3 credits)
Design of municipal water and wastewater treatment plants. Emphasis on characterization of water and wastewater and physical, chemical, and biological treatment methods. Sludge processing advanced treatment methods and treatment plant hydraulics are considered. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4114 - Fundamentals of Public Health Engineering (3 credits)
Public health engineering principles for protection against biological and chemical health hazards. Emphasis on major communicable diseases that plague mankind, organisms that cause them, routes of transmission, and engineering methods of control. Appropriate control methods for rural areas and developing countries.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4134 - Environmental Sustainability - A Systems Approach (3 credits)
Quantitative methods to evaluate environmental sustainability using a sytems approach. Sustainability assessment frameworks, oreintors and indicators, indicators of sustainable development, green-house gas emissions, renewable energy systems, whole-system design, economic systems and input-outpur techniques, system dynamics models, emergence and agent-based models. Class project requiring integration of environmental, economic and social systems using system dynamics and agent-based models. Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4144 - Air Resources Engineering (3 credits)
Effects, regulation, sources, and control of air pollution. Application of engineering calculations and models to estimate emissions, predict pollutant concentrations, and design pollution control equipment. Senior standing required. A grade of C- or better required in prerequisites.
Prerequisite(s): CEE 3104 or ENGR 3124 or GEOS 3114 or ENSC 3634
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4174 - Solid and Hazardous Waste Management (3 credits)
Introduction to the problems, regulations and techniques associated with the management of solid and hazardous waste. Composition, volume and characterization of the wastes. Design of collection and disposal systems, including landfills, solidification/stabilization and incineration. A grade of C- or better required in pre-requisite 3104.
Prerequisite(s): CEE 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4254 - Municipal Engineering (3 credits)
An introduction to the field of municipal engineering. Infrastructure, capital projects, financing, sustainability, disaster planning and response, and plan review for development projects. Senior standing required.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4264 - Sustainable Land Development (3 credits)
An introduction to the modern techniques for developing land while maintaining a focus on long-term sustainability. Topics include site layout, stormwater impact, air quality and microclimate, living resources, LEED and EarthCraft development standards. Pre-requisite: Senior Standing required
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4274 - Land Development Design (3 credits)
Overview of land development projects including construction practices, legal issues, and government policies. Feasibility study, engineering evaluation. Grading and roadway design, layout design of lots, buildings, streets, sewers, and stormwater control. Interactive graphics and automated drafting.
Prerequisite(s): CEE 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4284 - Advanced Land Development Design (3 credits)
Advanced course in land development design focusing on site grading and parking, stormwater management, and erosion control. Reviews project design criteria and applicable municipal and state guidelines. Uses CAD software for design and deliverables. Senior/Graduate standing required.
Prerequisite(s): CEE 3274
Corequisite(s): CEE 4274
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4304 - Hydrology (3 credits)
Precipitation, evaporation, consumptive use, infiltration; stream flow, flood routing; statistical analysis of hydrologic data, flood and drought forecasting, risk analysis, subsurface flow, well hydraulics, introduction to urban drainage design. A grade of C- or better required in pre-requisite.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4314 - Groundwater Resources (3 credits)
Fundamentals of groundwater hydrology; flow through porous media, both saturated and unsaturated; flow to wells in both confined and unconfined aquifers; seepage of groundwater to canals and field drains; analysis of aquifer test data to quantify flow and storage parameters; contaminants in groundwater, basic introduction to groundwater modeling. A grade of C- or better required in pre-requisite 3304.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4324 - Open Channel Flow (3 credits)
Mechanics of open channel flow, including uniform flow, gradually varied flow, channel transitions, and unsteady flow.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4334 - Hydraulic Structures (3 credits)
Hydraulic analysis and design of engineering structures for water control, including reservoirs, dams, spillways, spilling basins, drainage structures, and hydraulic models.
Prerequisite(s): CEE 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4344 - Water Resources Planning (3 credits)
Analysis of the water resources planning process and the institutional framework for water resources management. Criteria and procedures for evaluating management alternatives are examined, with emphasis on assessment of economic and environmental impacts. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4384 - Coastal Engineering (3 credits)
Basic wave mechanics principles, surf-zone processes, littoral and sediment processes, shoreline features, astronomical tides, coastal hazards, and functional design of coastal structures. Field trips.
Prerequisite(s): CEE 3304
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4394 - Urban Water Sustainability (3 credits)
Coupled socio-hydrologic feedback loops and implications for water systems resilience. Urban water transitions theory and the evolution of water systems through time. Water productivity and the soft path for water. Ecosystem services. Urban water system challenges, including climate change, urbanization, equity and environmental justice, and water security. Centralized and distributed drinking water, stormwater, and wastewater treatment systems. Statistical analysis of urban water systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4404 - Intermediate Structural Analysis (3 credits)
Analysis of statically indeterminate 2D and 3D beam, truss and frame structures by the force and displacement methods. Computer implementation of force method. Influence lines and approximate methods of analysis.
Prerequisite(s): CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4454 - Masonry Structural Design (3 credits)
Masonry materials, material testing, material specifications. Structural behavior and design of masonry elements (walls, beams, and columns) and systems used in structures. Construction techniques and the details of masonry construction. Building codes relating to analysis and design of masonry structures.
Prerequisite(s): CEE 3684 and CEE 3424
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4514 - Methods in Geotechnical Engineering (3 credits)
Principles and techniques for characterizing earth materials (soil and rock) for civil engineering projects in various regional environments; with emphasis on the interdisciplinary approach to field exploration and site description through soil mechanics theory, geologic correlations, geophysical methods, in site testing and sampling. A grade of C- or better required in pre-requisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4534 - Earth Pressures and Foundation Structures (3 credits)
Earth pressure theories and their applications to the design of retaining structures, anchors, and excavation bracing. Bearing capacity and settlement of shallow foundations. Types and capacity of deep foundations.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4544 - Design of Earth Structures (3 credits)
Application of geotechnical engineering principles in the design and construction of earth structures. Subsurface models, shear strength of soil, slope stability, earth fills, earth retention, ground improvement, sustainability considerations, geotechnical reporting. Team-based design project.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4554 - Natural Disaster Mitigation and Recovery (3 credits)
Causes, mechanics, classifications, and forces associated with tornadoes, hurricanes, floods, earthquakes, and landslides. Resistance evaluation for existing ground, facilities and structures. Hazard-resistant design of new facilities. Risk and reliability assessment and decision analysis. Strategies and designs for natural disaster risk mitigation. Emergency response for protection of life and property and restoration of lifelines. Includes an interdisciplinary team project. Prerequisite: Senior Standing Required
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4564 - Introduction to Coastal and Marine Geotechnics (3 credits)
Geotechnical aspects of coastal and marine engineering. Introduction to the coastal zone as a working environment. In-situ geotechnical methods and complementary techniques for investigation. Survey strategies. Local field trips for demonstrating methods, practice and design. A grade of C- or better is required in prerequisite 3514.
Prerequisite(s): CEE 3514
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4604 - Traffic Engineering (3 credits)
Study of traffic and parking characteristics; application of traffic control devices; principles and techniques used to improve the efficiency and safety of traffic flow systems. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4610 - Mechanics of Composite Materials (3 credits)
Introduction to the deformation, stress, and strength analysis of continuous-fiber-polymer-matrix laminated composites. Fabrication, micromechanics of stiffness and expansional coefficients, classical lamination theory (CLT). Environmentally induced stresses. Computerized implementation and design
Prerequisite(s): ESM 2204 or AOE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ESM 4044

CEE 4614 - Concrete Materials (3 credits)
Fundamental properties of portland cement concretes. Concrete mixture design procedures. Testing of fresh and hardened properties of concrete. Durability and degradation mechanisms. Condition assessments, forensic materials engineering, and repair strategies.
Prerequisite(s): CEE 3684 or BC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4624 - Planning Transportation Facilities (3 credits)
Transportation planning process; urban and regional studies, surveys, data analysis, model development and testing; transportation management, administration, finance, system evaluation, implementation, and integration.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4634 - Infrastructure Condition Assessment (3 credits)
Infrastructure components and assessment needs; physical and chemical properties of construction materials; deterioration causes, assessment methods, nondestructive evaluation techniques, infrastructure management systems, performance models, service-life-cycle estimates.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4654 - Geometric Design of Highways (3 credits)
Functional design of highways; curves, intersections, interchanges, drainage, and other features involved in highway safety and traffic efficiency.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4664 - Pavement Design (3 credits)
Principles underlying methods for the design of various elements of flexible and rigid pavements for highways and airports; climate and traffic effects; pavement management systems. A grade of C- or better required in pre-requisite 3684.
Prerequisite(s): CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4674 - Airport Planning and Design (3 credits)
Airport planning and economic justification, site selection, configuration, development and design of terminal areas, demand forecasting, access, traffic control. A grade of C- or better required in pre-requisite 3604.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4684 - Transportation Safety (3 credits)
Basic principles associated with transportation safety related to humans, vehicles and infrastructure as well as principles of design for safety and practices of empirical evaluation of safety. Principles and practices of accident investigation and injury epidemiology as well as safeguards and control practices. A grade of C- or better required in prerequisite.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4694 - Freight Operations (3 credits)
Introduction to the operation of modal and intermodal freight facilities. Impact of goods movement on the multi-modal transportation system. Role of privately owned and operated goods movement on public sector transportation operations, management, and decision making. Communication of impacts.
Prerequisite(s): CEE 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4804 - Professional and Legal Issues in Civil Engineering (3 credits)
An overview of civil engineering professional practice, including business etiquette, professional development, leadership, and lifelong learning. Emphasizes the importance of registration for civil engineers. Compares and contrasts common project delivery methods, processes, key players, and management topics for the design and construction industry. Incorporates analyses of legal and ethical aspects of civil engineering practice. Analyzes contemporary issues and public policies that impact the civil engineering profession, and the impacts of civil engineering solutions on society. Emphasizes effective written, oral, and visual professional communication for the civil engineering professional. For Pathways Advanced Discourse credit, must complete combination of CEE 2804, CEE 3304, CEE 4804
Prerequisite(s): CEE 2804
Corequisite(s): CEE 3304
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4814 - Risk and Reliability Analysis in Civil and Environmental Engineering (3 credits)
Risk assessment and reliability analysis as applied to civil engineering applications. Identification and modeling of non-deterministic problems in civil engineering design and decision making. Application of probability and statistics to performance analysis. Development of probabilistic engineering safety assessments.
Prerequisite(s): CEE 3804
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4824 - Introduction to Forensic Engineering (3 credits)
Basic processes in engineering failure investigations: response, data gathering, testing, modeling, and reporting. Origins of natural and man-made disasters, role of building codes and material specifications, standard of care, ethical standards and legal issues as related to forensic engineering.
Prerequisite(s): CEE 3684 and ESM 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4834 - Cyber-Physical and Remote Sensing Methods in Civil Engineering (3 credits)
Cyber-physical systems and remote sensing methods in civil engineering. Electrodynamics and fundamental physical operating principles. Sensing and sensor deployment strategies. Data acquisition and reduction. Signal and image processing techniques. Data interpretation, management, and curation.
Prerequisite(s): CEE 3814 or BSE 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4844 - Building Information Modeling and Integrated Practices (3 credits)
Introduction to Building Information Modeling (BIM). Architectural modeling, custom parametric object creation, virtual structural modeling. Constructability and construction management analysis. Reality capturing technologies. Virtual reality and immersive virtual environments. Contemporary topics and new directions for BIM technologies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CEE 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CEM)

CEM 1974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 2104 - Introduction to Construction Engineering and Management (3 credits)
Overview of the construction engineering and management profession specialty areas. Introduction to the undergraduate program of study. Fundamentals of effective oral, written and visual communication skills. Professionalism, ethics, and legal issues relating to the industry. Contemporary issues facing the industry. Engineering library resources. Project drawings, computer aided design (CAD), and responding to Requests for Proposals (RFPs).
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2404 - Construction Project Documents (1 credit)
Interpret design documents for construction projects. Analyze project documents to select appropriate construction engineering methods. Quantify materials using appropriate methods and technology. Review and comparison of construction documentation in various industry sectors. Identify information required for construction that is missing or ambiguous in the design documentation. Create and analyze a request for information (RFI) to modify and update the project documentation.
Corequisite(s): CEM 2104
Instructional Contact Hours: (3 Lab, 1 Crd)

CEM 2714 - Construction Safety Systems (3 credits)
Introduction to construction safety and the importance of safety, health, and wellness in the construction industry. Identify systematic safety issues and safety management systems, evaluation of safety systems through MEAD (MacroErgonomic Analysis and Design) methodology to recommend safety management systems to improve safety outcomes on construction operations. Assess health, safety, and wellness initiatives for construction worker safety and well-being. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 2824 - Construction Site Analysis (3 credits)
Geospatial information, Global Positioning Systems (GPS), surveying, and aerial photography for condition assessment, solving construction engineering problems, and managing construction control processes. Topographic survey methodology for field layout and stakeout processes in construction. Geospatial data collection techniques for construction risk analysis. Document existing site conditions. Use of software, and custom program tools. Individual and team projects and presentations.
Corequisite(s): 2104 or BC 1224 or CEE 2834.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

CEM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 3024 - Construction Estimating and Scheduling (3 credits)
Introduction to estimating and scheduling of construction operations using construction documents. Quantity takeoff, resource and crew enumeration, network logic, activity durations, Critical Path Method (CPM) and Location-Based Management System (LBMS). Bid assembly with markups. Construction decisions based on ethical principles. A grade of C- or better is required in prerequisite.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3064 - Intro to Lean Construction (3 credits)
Introduction to Lean Construction thinking, principles, and practices, definitions, history, theory, and fundamentals related to project production systems. Operating system, organization practices, commercial terms. Pull planning and Last Planner System, teh Big Room concept, and Integrated Form of Agreement (IFOA). Conventional Lean practices A3 problem solving, 5 Whys Root Cause Analysis, and 5s Methadology. Continuous improvement, respect for people, elimination of waste, reducing variability and increasing plan reliability.
Prerequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3074 - Global Design and Construction for Sustainable Development (3 credits)
A collaborative approach for applying engineering systems and design to global issues. Design, engineering, and construction focused on social responsibility in the global village. Multi-disciplinary teamwork requiring identification of client needs and design considerations, development of site layouts, selection of resources, management of schedule, cost, materials, personnel, quality, and jobsite safety. Applied conflict handling skills and self-reflection on social responsibility, service, intercultural global awareness, and evaluating the success of sustainable projects. May be repeated one time with different content for a maximum of six credits. Multi-day field trip required. Pre: Junior Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CEM 3084 - Construction Economy (3 credits)
Engineering economics, accounting, finance, and entrepreneurship. Construction financial management and financial decision-making. Construction financial risk, estimation, and generation of financial statements. Construction company creation and business plan development. Assessment of construction project delivery methods and impacts of retainage, bonding, and taxation.
Prerequisite(s): CEM 2104 or BC 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3134 - Temporary Structures in Construction (3 credits)
Introduction to temporary structure systems used to support construction operations. Concrete formwork, scaffolding systems, excavation shoring systems, dewatering techniques, and hoisting operations. Assessment of systems, cost, quality, safety, sustainability, and schedule impacts.
Prerequisite(s): (BC 2044 and BC 2024 and BC 2214) or CEE 3684
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BC 3134

CEM 3154 - Smart Construction (3 credits)
Introduction to smart construction, definitions, principles and practices. Exploration of inefficiencies associated with the traditional approaches to construction. Intelligence requirements of the building lifecycle. Smart planning and contracting practices, and facilitating technologies. Smart design principles, techniques, technologies, strategies for involving down-stream stakeholders in the design of buildings for constructability and maintainability. Overview of digital infrastructure, types, selection and role in integrating the design and construction phases.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3164 - Construction Health and Safety (3 credits)
Introduction to fundamentals of Occupational Health and Safety (OHS) for the construction industry. History of OHS regulation and specific governmental regulations, standards and laws. Health, safety, and environmental hazards identification. Methods of quantifying exposure and estimating risk. Design and prioritization of control solutions to mitigate hazards. Contemporary issues and theoretical frameworks in the field of OHS management relevant to the industry. Prevention through Design, behavior-based safety, different construction project delivery methods, safety climate and culture, control banding, and systems safety.
Corequisite(s): CEM 2104 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3714 - Controlling Construction Safety Hazards (3 credits)
Perceive, recognize (cognitive recall), and examine/classify (decision making) construction safety hazards and their underlying energy sources. To control hazards, the construction hierarchy of controls guides a safety by design methodology. Accident investigation or forensic processes using design-based arguments to determine root causes of incidents. Pre: Sophomore Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4024 - Construction Law and Contract Administration (3 credits)
Application of contract law, torts, and statutory law in construction. Legal context, parties, interpreting contracts and specifications, contract changes, differing site conditions, delays, disruptions, and acceleration. Dispute avoidance and resolution. Ethics and risk management. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4314 - Design of Wood Structures (3 credits)
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls.
Prerequisite(s): SBIO 3314 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 4314

CEM 4445 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3024
Corequisite(s): CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4446 - CEM Capstone (3 credits)
4445: Preliminary design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. 4446: Final design of infrastructure, planning and scheduling of design and construction, cost estimating and budgeting, life cycle cost analysis, application of technology to support construction, maintenance, and facilities operation, and project risk management. Collaboration-based course utilizing design-build project delivery methodology. Design and construction considerations include public health, safety, and welfare, as well as global, cultural, social, ethical, environmental, and economic factors. Underpinning themes include safety and constructability by design, sustainability, resilience, and reliability. The final deliverable includes a comprehensive written proposal and oral presentation. Pre: Senior standing.
Prerequisite(s): CEM 3084 and CEM 4445 and CEM 3134
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4624 - Construction Robotics and Automation (3 credits)
Automation and its application in construction. Automated problem-solving methodologies in Building Information Modeling (BIM) and data interoperability solutions. Robotics and the application of robotic technologies in construction considering safety and technical operation requirements in construction environments and robot programming and controls. Unmanned Aerial Vehicles (UAVs) or drones in construction projects. Emerging areas of research in the field of construction automation and robotics. No programming background is required.
Prerequisite(s): BC 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4634 - Data Analysis and Visualization for Construction and Facilities Management (3 credits)
Introduction to data analysis and visualization theories and techniques applied in the construction and facilities management domain. Data collection, processing, storage, analysis, and visualization methods in the context of construction and building management. Data-driven decision making.
Prerequisite(s): (CEM 2104 or BC 2024 or CEE 3014) and (BC 2114 or CEE 3804)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4644 - Artificial Intelligence for Design, Construction, and Operations (3 credits)
Evaluate the basic concepts and computational tools of artificial intelligence (AI), machine learning, and deep learning in the architecture, engineering, and construction (AEC) industry. Appraise the history and potential to improve automation, digitalization, and diversity and inclusion in the industry. Develop practical expertise in formulating, deploying, and evaluating deep learning models, including convolutional neural networks, pretrained computer vision models, sequential models, and generative AI, through hands-on projects such as infrastructure health monitoring, safety management, and building energy consumption prediction. Foster real-world application of knowledge through project-based learning.
Prerequisite(s): (MATH 2114) and (ENGE 1215 or CS 1014 or ENGE 1414 or CS 1054 or CS 1064 or CS 1114)
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4714 - Construction Safety Culture (3 credits)
Examination of construction safety culture and climate and the role of organizational leadership in ethical safety practices. Analyze safety cultures within the construction industry for recommendations of change to shape safety practices.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4724 - Construction Industry Futures: Safety, Health, and Wellness (3 credits)
Evaluate the future of the construction industry dynamics (trends, drivers, and disruptors) relative to their impacts on safety, health, and wellness. Compare global construction safety performances and practices. Design adaptable safety, health, and well-being management systems of the future based on technology-human interfaces, climate change, and globalization in construction.
Prerequisite(s): CEM 2104 or CEM 2714 or BC 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

CEM 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CEM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Construction Engineering and Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CEM 2404	Construction Project Documents	1
CEM 2824	Construction Site Analysis (C-)	3
CEM 3024	Construction Estimating and Scheduling	3
CEM 3134	Temporary Structures in Construction	3
CEE 3404	Introduction to Structural Engineering	3
CEE 3514	Introduction to Geotechnical Engineering	4
CEE 3684	Civil Engineering Materials	4
CEM 4024	Construction Law and Contract Administration	3
CEE 4074	Construction Engineering: Means and Methods	3
CEM 4445	CEM Capstone	3
Subtotal		30
Additional Course Requirements		
BC 2114	Information Technology in Design and Construction	3
BC 3114	Building Systems Technology	3
BC 3064	Integrated Construction II	3
BC 4064	Integrated Construction III	3
ESM 2104	Statics	3
ESM 2204	Mechanics of Deformable Bodies (C-)	3
GEOS 2104	Elements of Geology (C-)	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
STAT 3704	Statistics for Engineering Applications	2
Technical Electives		6
Advanced Course		6
Career Bridge Experience [1]		
ENGE 3900	Bridge Experience	0
Subtotal		41
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
CEM 2104	Introduction to Construction Engineering and Management (1A ; C-)	3
CEM 3084	Construction Economy (1A)	3
CEM 4446	CEM Capstone (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics (3)	3
ECON 2006	Principles of Economics (3)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035 & CHEM 1045	General Chemistry and General Chemistry Laboratory (4; C-)	4
PHYS 2305	Foundations of Physics (4)	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F ; C-)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A ; C-)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
ENGE 1215 & ENGE 1216	Foundations of Engineering and Foundations of Engineering (6D)	4
or ENGE 1414	Foundations of Engineering Practice	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 should be double counted with either Pathway 2 or 6a to avoid taking additional credit hours.		

Subtotal	53
Total Credits	**124**

Advanced Courses

The CEM degree requires 6 hours of advanced courses. Advanced courses may be selected from the following list:

Code	Title	Credits
CEE 3424	Reinforced Concrete Structures I	3
CEE 4404	Intermediate Structural Analysis	3
CEE 4454	Masonry Structural Design	3
CEE 4514	Methods in Geotechnical Engineering	3
CEE 4534	Earth Pressures and Foundation Structures	3
CEE 4544	Design of Earth Structures	3
CEE 4564	Introduction to Coastal and Marine Geotechnics	3
CEE 4610	Mechanics of Composite Materials	3
CEE 4614	Concrete Materials	3
CEE 4634	Infrastructure Condition Assessment	3
CEE 4664	Pavement Design	3
CEM 4314	Design of Wood Structures	3

Technical Electives

The CEM degree requires 6 hours of technical electives. Students can choose to focus on one area of emphasis or can pick and choose courses from multiple areas. Directed electives may be any 3000-5000 level engineering course (courses with prefix: AOE, BMES, BSE, CEE, CEM, CHE, CS, CEC, ENGE, ENGR, ESM, ISE, ME, MINE, MSE, NSEG). Electives in CEM focus areas are listed below:

Code	Title	Credits
Virtual Design		
BC 4114	Building Information Modeling in Design and Construction	3
BC 4124	Digital Construction and Manufacturing	3
BC 4364	Lifecycle BIM for Facility Management	3
Transportation		
CEE 3604	Introduction to Transportation Engineering	3
Management		
CEM 3064	Intro to Lean Construction	3
ACIS 1004	Accounting Foundations	3
CEE 3804	Computer Applications for Civil and Environmental Engineers	3
ISE 4004	Theory of Organization	3
MGT 3304	Management Theory and Leadership Practice	3
Risk Management & Consulting		
CEE 4814	Risk and Reliability Analysis in Civil and Environmental Engineering	3
FIN 3054	Legal and Ethical Environment of Business	3
CEE 4824	Introduction to Forensic Engineering	3
Safety		
CEM 2714	Construction Safety Systems	3
CEM 3164	Construction Health and Safety	3
CEM 3714	Controlling Construction Safety Hazards	3
CEM 4714	Construction Safety Culture	3
CEM 4724	Construction Industry Futures: Safety, Health, and Wellness	3
Smart Construction		
CEM 3154	Smart Construction	3
ECE 3054	Electrical Theory	3
CEM 4624	Construction Robotics and Automation	3
CEM 4634	Data Analysis and Visualization for Construction and Facilities Management	3
CEM 4644	Artificial Intelligence for Design, Construction, and Operations	3
Sustainability		
CEM 3074	Global Design and Construction for Sustainable Development	3
ENGR 3124	Introduction to Green Engineering	3
ENGR 4134	Environmental Life Cycle Assessment	3
ME 4194	Sustainable Energy Solutions for a Global Society	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
BC 3014	Building Physics and Environmental Systems	3
Others		
CEM 4964	Field Work/Practicum [2]	1-19
CEM 4974	Independent Study [2]	1-19
CEM 4994	Undergraduate Research [2]	1-19
REAL 2004	Principles of Real Estate	3

[1] Career Bridge Experiences help prepare students for post-graduation life and develop a professional identity. Internships, Co-ops, and Undergraduate Research are examples of possible Career Bridge Experiences. Students must participate in a Career Bridge Experience to complete the BS CEM degree. Because some of these experiences are not credit bearing, the ENGE 3900 course is used to track and assess student participation in a Career Bridge Experience and to record fulfillment of this degree requirement on the transcript. Students should enroll in ENGE 3900 during the semester (or one of the semesters) that they undertake the Career Bridge Experience. Enrollment in ENGE 3900 requires approval of a Career Bridge Plan.

Further information about acceptable Career Bridge Experiences and the process for submitting a Career Bridge Plan are explained in CEM 2104.

[2] Course must be taken for 3 credit hours.

Satisfactory Progress Towards Degree

University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The Myers-Lawson School of Construction fully supports this policy. Specific expectations for satisfactory progress for CEM majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (http://www.undergradcatalog.registrar.vt.edu.)
- A 2.0 overall GPA and a 2.0 in-major GPA must be maintained for continued enrollment in CEM.
- Upon completion of 64 hours, students must have completed CEM 2824 Construction Site Analysis and ESM 2204 Mechanics of

Deformable Bodies with a C- or better and have a minimum 2.0 in-major and a minimum 2.0 overall GPA.

Graduation Requirements

Students must pass all required courses, complete a professional bridge experience, and both the in-major and overall GPA must be at least 2.00 for graduation.

In-Major GPA

Consists of all courses taken under the CEE, CEM and BC designation.

Acceptable Substitutions

- MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra
- MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra, MATH 2204 Introduction to Multivariable Calculus, AND MATH 2214 Introduction to Differential Equations
- CEE 2814 Geomatics may be substituted for CEM 2824 Construction Site Analysis and CEM 2404 Construction Project Documents
- STAT 4604 Statistical Methods for Engineers may be substituted for STAT 3704 Statistics for Engineering Applications
- CEE 3434 Design of Steel Structures I may be substituted for an advanced course.

Foreign Language Requirement

Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

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Roadmap

First Year		
Fall Semester		**Credits**
CHEM 1035	General Chemistry (C-)	3
CHEM 1045	General Chemistry Laboratory (C-)	1
ENGE 1215	Foundations of Engineering (C-)	2
ENGL 1105	First-Year Writing	3
MATH 1225	Calculus of a Single Variable (C-)	4
Pathway 2		3
	Credits	**16**
Spring Semester		
ENGE 1216	Foundations of Engineering (C-)	2
ENGL 1106	First-Year Writing	3
MATH 1226	Calculus of a Single Variable (C-)	4
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics	4
	Credits	**16**
Second Year		
Fall Semester		
CEM 2104	Introduction to Construction Engineering and Management (C-)	3
CEM 2404	Construction Project Documents	1
ESM 2104	Statics	3
GEOS 2104	Elements of Geology (C-)	3
MATH 2204	Introduction to Multivariable Calculus	3
ECON 2005	Principles of Economics	3
	Credits	**16**
Spring Semester		
BC 2114	Information Technology in Design and Construction	3
CEM 2824	Construction Site Analysis (C-)	3
CEE 4074	Construction Engineering: Means and Methods	3
ESM 2204	Mechanics of Deformable Bodies (C-)	3
MATH 2214	Introduction to Differential Equations	3
	Credits	**15**
Third Year		
Fall Semester		
BC 3114	Building Systems Technology	3
CEE 3404	Introduction to Structural Engineering	3
CEE 3684	Civil Engineering Materials	4
CEM 3024	Construction Estimating and Scheduling	3
CEM 3084	Construction Economy	3
ENGE 3900	Bridge Experience	0
	Credits	**16**
Spring Semester		
BC 3064	Integrated Construction II	3
CEE 3514	Introduction to Geotechnical Engineering	4
ECON 2006	Principles of Economics	3
CEM 3134	Temporary Structures in Construction	3
STAT 3704	Statistics for Engineering Applications	2
	Credits	**15**
Fourth Year		
Fall Semester		
BC 4064	Integrated Construction III	3
CEM 4445	CEM Capstone	3
Advanced Course		3
Technical Elective		3
Pathways 2, 7		3
	Credits	**15**
Spring Semester		
CEM 4446	CEM Capstone	3
CEM 4024	Construction Law and Contract Administration	3
Advanced Course		3
Technical Elective		3
Pathways 6a		3
	Credits	**15**
	Total Credits	**124**

Liberal Arts and Human Sciences

Our Website (http://www.liberalarts.vt.edu)

Overview

The College of Liberal Arts and Human Sciences offers baccalaureate degrees encompassing the humanities and human and social sciences. The College emphasizes the importance of mastering the intellectual skills a liberal arts education develops as well as job skills by encouraging students to apply knowledge from a field and to think creatively. Learn more about our strategic plan (https://liberalarts.vt.edu/content/dam/liberalarts_vt_edu/ood/CLAHS-Strategic-Plan-2024.pdf).

Outstanding faculty members conduct research and teach courses in 11 departments and 3 schools leading to baccalaureate and advanced degrees. Coursework from the College of Liberal Arts and Human

Sciences also provides a foundation of knowledge in fundamental subjects for students in all colleges through the Pathways General Education (https://www.pathways.prov.vt.edu/) program.

The college offers minors in many areas of study. Students are encouraged to include a minor in their program and should consult an advisor for help in choosing one that will advance their career goals.

General Requirements for Graduation

A student in the College of Liberal Arts and Human Sciences must complete at least 120 hours for an undergraduate degree as well as satisfy the following requirements:

- achieve a minimum overall Grade Point Average (GPA) of 2.0 for all hours attempted
- achieve a minimum overall GPA of 2.0 for all hours attempted in all work applied to the major
- complete all other requirements established for their degree by the major department
- complete all college and university Pathways General Education requirements
- complete the language study requirement either through high school enrollment or before receipt of the undergraduate degree.
  - The minimum requirement may be met in high school by completing 2 units of a single foreign or classical language or American Sign Language. Some majors in the College of Liberal Arts and Human Sciences may require 3 units of a single foreign or classical language or American Sign Language.
  - Students who do not complete the University Foreign Language requirement by completing 2 years of the same foreign language in high school must take 1105 and 1106 of a foreign language at the college level. These hours will not count toward the minimum hours required for graduation.

No course required for graduation or in the major/minor may be taken on a pass/fail basis, excluding courses that are offered pass/fail only. (i.e., pass/fail may be used for free electives only).

Pathways General Education

A description of the Pathways General Education curriculum may be found in the Academics (p. 9) section of this catalog. For requirements specific to departments in the College of Liberal Arts and Human Sciences, please contact the individual department.

Honors College

The Honors College is available to students in the College of Liberal Arts and Human Sciences. This program provides an enriched environment for qualified and highly motivated students. More information about honors academic requirements and how to earn an honors diploma is available on the Honors College website: **honorscollege.vt.edu**

Dean's List

An undergraduate student who attempts at least 12 credit hours graded on the A-F option and earns a 3.4 GPA for either spring or fall semester will be included on the online Dean's List for that term. Please note: Students will not appear on the online Dean's List if they are listed in the system as confidential or do not have an active permanent address. Questions about omissions from the online list should be directed to the Office of the University Registrar.

Scholarships

Scholarships are available for students enrolled in the College of Liberal Arts and Human Sciences. Descriptions and deadlines are available on the **college website** and on the **Office of University Scholarships and Financial Aid**.

Experiential Learning: Internships, Study Abroad, and Undergraduate Research

Educational experiences outside the classroom help make students more competitive for internships, jobs, and graduate school applications. Participation in internships, study abroad, and undergraduate research helps prepare students for life after graduation while exposing them to complex cultural issues. Every major offers academic and career advising to support students in connecting with current opportunities. Course credit is available for qualifying experiences.

Academic Advising

The College of Liberal Arts and Human Sciences includes faculty advisors and a team of professional (https://liberalarts.vt.edu/beyond-the-classroom/academic-and-career-advising.html), award-winning Academic Advisors whose primary role is to support students in working toward their personal, academic, and career goals. Each student is assigned to work with at least one academic advisor, depending upon any additionally declared minors or majors. Advisors are prepared to guide students, as partners, through various processes during their time at Virginia Tech including:

- exploring and solidifying major(s) and/or minor(s)
- determining course selections
- developing semester schedules
- creating and adjusting academic plans
- understanding transfer credits
- considering experiential opportunities like study abroad or internships, and
- connecting with appropriate resources and individuals across campus

Career Advising

Career advising is available from multiple sources. The centralized Career and Professional Development (https://www.career.vt.edu), located at the Smith Career Center, offers many services to support the career journey. Beginning with career and major exploration, through the process of assisting students in the job search or graduate and professional school application, Career and Professional Development advisors are a resource for all students.

The College of Liberal Arts and Human Sciences works with employers interested in hiring students to host information sessions and panels. Students can attend multiple career fairs offered on campus to build their network, secure internships, or apply for full-time jobs. Every major also offers a career advisor (https://liberalarts.vt.edu/beyond-the-classroom/internships.html) who specializes in guiding students toward career success.

Pre-Professional Advising

The University provides pre-professional career advisors for all disciplines and the college provides career advisors in areas related to the College.

- Pre-law advising (https://www.prelaw.psci.vt.edu/main/advise.htm) connects students with faculty advisors, student organizations, and related academic opportunities. The advising program, sponsored by the College of Liberal Arts and Human Sciences, is open to students from all majors who are interested in the law. Students may also select majors that offer pre-law concentrations or degree options to help prepare for graduate programs in law. A pre-law student organization is available for interested students.
- Health Professions Advising (https://career.vt.edu/advising/hpa.html) at Virginia Tech assists students in exploring healthcare careers and preparing to apply to professional schools for medicine, dentistry, optometry, pharmacy, chiropractic, occupational therapy, nursing, physician assistant, veterinary medicine, and other health Professions. The advising program is supported by Career and Professional Development and is open to students in all majors.

Graduate Programs

Many of the College of Liberal Arts and Human Sciences departments offer graduate degrees at the Master's and Ph.D. levels. Complete information on these programs, including descriptions of graduate courses, can be found in the Graduate Catalog (https://catalog.vt.edu/graduate/).

- Advertising Major (p. 1119)
- Applied Public Policy Studies Major Option (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/political-science/applied-public-policy-studies/)
- Arabic Major (p. 1056)
- Career and Technical Education - Agricultural Education Major (p. 1135)
- Career and Technical Education Major with Business and Information Technologies Education Option (p. 1136)
- Career and Technical Education Major with Family and Consumer Sciences Education Option (p. 1137)
- Career and Technical Education Major with Marketing Education Option (p. 1138)
- Classical Studies Major (p. 1057)
- Communication Major (p. 1121)
- Consumer Studies Major (p. 966)
- Creative Writing Major (p. 986)
- Criminology Major (p. 1163)
- Early Childhood Development and Education Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/human-development-family-science/early-childhood-dvlp-educ-bs/)
- Elementary Education (PK-6) Major (p. 1139)
- English Language Arts Education Major (p. 1140)
- English Major with Literature Option (p. 987)
- English Major with Pre-Education Option (p. 989)
- English Major with Pre-Law Option (p. 990)
- Environment, Development, and Global Economy Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/international-studies/environment-development-and-global-economy-major/)
- Environmental Policy and Planning Major (p. 1146)
- EUropean & Transatlantic Studies Major (p. 1023)
- Fashion Merchandising and Design Major (p. 968)
- French Major (p. 1059)
- German Major (p. 1060)
- History and Social Sciences Education Major (p. 1141)
- History Major (p. 1002)
- History Major with Undergraduate Research/Thesis Option (p. 1004)
- Human Development Major (p. 1009)
- Humanities for Public Service Major (p. 1109)
- International Relations Major (p. 1026)
- International Studies Major (p. 1029)
- Mathematics Education Major (p. 1142)
- Multimedia Journalism Major (p. 1123)
- National Security & Foreign Affairs Major (p. 1034)
- Philosophy Major (p. 1070)
- Philosophy Major with Pre-Medical Professions Option (p. 1071)
- Philosophy, Politics, and Economics Major (p. 1072)
- Political Science Major (p. 1090)
- Political Science Major with Legal Studies Option (p. 1092)
- Political Science Major with National Security Studies Option (p. 1093)
- Political Science Major with Social and Political Justice Option (p. 1095)
- Property Management Major (p. 969)
- Public Relations Major (p. 1125)
- Religion and Culture Major (p. 1110)
- Residential Environments & Design Major (p. 971)
- Russian Major (p. 1061)
- Smart and Sustainable Cities Major (p. 1148)
- Sociology Major (p. 1165)
- Spanish Major (p. 1062)
- Sports Media and Analytics Major (p. 1127)
- Technical and Scientific Communication Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/english/technical-scientific-communication-ba/)
- Technology Education Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/education/technology-education/)

Dean: Laura Belmonte
Associate Dean for Academic Policies and Procedures: Debra Stoudt
Associate Dean for Global Initiatives and Engagement: Farida Jalalzai
Associate Dean for Graduate Studies and Research: Tom Ewing
Associate Dean for Transdisciplinary Initiatives and Chief Technology Officer: Carlos Evia
Associate Dean for Undergraduate Academic Affairs: Monica Kimbrell
Assistant Dean for Advancement: Michael Webb
Assistant Dean for Diversity, Equity and Inclusion: Shaila Mehra
Assistant Dean for Finance and Administration: Jenny Vincent
Director of Academic Advising: Amanda Weaver
Director of Student Recruitment: Kristy Morrill
Senior Director of Academic Support: Karen Watson

Air Force ROTC

Our Website (http://www.af.vt.edu)

Overview

The Air Force Reserve Officer Training Corps (AFROTC) provides a program of leadership development which prepares college men and

women for service as commissioned officers in the United States Air Force. After graduation, they assume active duty positions in both flying and non-flying specialties. To accomplish this, the Department of Aerospace Studies recruits, selects, retains, and commissions officer candidates as second lieutenants in the United States Air Force. AFROTC:

- Provides ethics and values education, stressing the Air Force core values of integrity first, service before self, and excellence in all we do.
- Prepares cadets to be commissioned as second lieutenants through a curriculum which develops leadership and management skills and provides opportunities to use these skills in a variety of practical applications.
- Provides an understanding of how to lead and influence small organizations, with a strong emphasis on personal integrity, honor, and individual responsibility. The techniques of effective leadership and quality management are stressed to achieve mission accomplishment.
- Enhances the cadets' understanding of the role of the military in society and provides an in-depth orientation to history and tradition of the Air Force and how the Air Force serves the nation. This goal is reinforced by summer hands-on leadership training and career orientation opportunities at Air Force bases around the country.
- In conjunction with the Virginia Tech Corps of Cadets, provides programs and experiences which increase self-confidence, self-discipline, accountability, physical stamina, poise, and other traits essential to the development of a leader of character who is prepared to serve the nation or the commonwealth both in and out of uniform.

The curriculum and leader development programs of the Department of Aerospace Studies are mentally and physically challenging. Cadets learn basic military skills and participate in a demanding physical conditioning program starting in the freshman year. The program moves progressively from followership to leadership experiences and culminates with the senior class cadets planning, organizing, and administering all leadership training for the cadet group. On-campus instruction is conducted both in the classroom by Air Force officers and in the field environment by both officer and cadet leaders. Semiannual visits to Air Force bases expand the cadets' knowledge of Air Force operations and life-style. A demanding summer field training encampment prior to the junior year prepares the cadet for acceptance into the commissioning track.

Air Force ROTC offers four-, and three-year tracks. Four- and three-year track cadets must complete 4 semester hours of AFROTC academics prior to a two-week summer encampment. Students who have Junior ROTC, other-service ROTC, national guard, reserve, or active duty military experience may request credit and advanced placement.

Scholarships

Air Force ROTC offers four-, three-, and two-year scholarships which are based on merit, not need. Though scholarship awards vary, most pay all/partial tuition, books, and approved university fees. High school seniors who are interested in the four-year or guaranteed three-year scholarships must apply at https://www.afrotc.com by February 1 of their senior year. Non-scholarship cadets may apply for three- and two-year scholarships during their freshman and sophomore years. All students who are contracted into the AFROTC program (to include all scholarship winners and those juniors and seniors holding a commissioning contract) receive a tax-free stipend of up to $500 per month while in school.

Virginia Tech requires membership in the Virginia Tech Corps of Cadets to be enrolled in ROTC. All freshman and sophomore cadets maintaining Air Force standards, as well as contracted junior and senior cadets, receive a special Air Force uniform allowance to offset the cost of cadet uniforms. The Corps of Cadets also provides need- and merit-based scholarships for deserving cadets.

Completion of Air Force ROTC may qualify a student to receive a minor in leadership and service from the College of Liberal Arts and Human Sciences.

Air Force ROTC builds leaders and offers every student who successfully completes the program a job upon graduation. The basic requirements for commissioning are: award of a degree from Virginia Tech, including a minimum of 24 hours of AFROTC; be a U.S. citizen of good moral character; meet medical and physical standards; achieve passing scores on the Air Force Officer Qualifying Test; and willingly accept a four-year active duty service commitment.

Head: Gregory B. Lowe, Col., USAF
Professor: Col Gregory B. Lowe
Assistant Professors: Maj Cade, Capt Cousin, Kate Lowe, Capt Penland, Lt Col Smith, and Capt Silverbush
Recruiting Officer: Capt Silverbush (231-5640)
Administrative Assistant: Connie Moses (231-6404)

Undergraduate Course Descriptions (AS)

AS 1115 - Introduction to the Air Force (1 credit)
Introduction to the United States Air Force and Air Force Reserve Officer Training Corps. Mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and introduction to communication skills.
Corequisite(s): AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 1116 - Introduction to the Air Force (1 credit)
Introduction to the United States Air Force and Air Force Reserve Officer Training Corps. Mission and organization of the Air Force, officership and professionalism, military customs and courtesies, Air Force officer opportunities, and introduction to communication skills.
Corequisite(s): AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2115 - Team and Leadership Fundamentals (1 credit)
A fundamental understanding of both leadership and team building. 2115: Followership, motivation, listening, problem solving, full-range leadership, standards and accountability, self-assessment, oral and written communication, and financial readiness of an Air Force officer. 2116: Human relations, team building models, ethical decision making, stress management and resiliency, and conflict resolution.
Prerequisite(s): AS 1115 and AS 1116
Corequisite(s): AS 2934, AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2116 - Team and Leadership Fundamentals (1 credit)
A fundamental understanding of both leadership and team building. 2115: Followership, motivation, listening, problem solving, full-range leadership, standards and accountability, self-assessment, oral and written communication, and financial readiness of an Air Force officer. 2116: Human relations, team building models, ethical decision making, stress management and resiliency, and conflict resolution.
Prerequisite(s): AS 2115
Corequisite(s): AS 2934, AS 2944
Instructional Contact Hours: (1 Lec, 1 Crd)

AS 2934 - Air Force Fitness (1 credit)
Reflects change in culture on physical fitness and incorporates fitness as a way of life with the United States Air Force & the Air Force Reserve Officer Training Corps (AFROTC). Structured to motivate members to develop and maintain year-round physical fitness conditioning program emphasizing total-body wellness to meet expeditionary mission requirements. Prepares cadets to tackle squadron fitness programs upon entering active duty. Course may be taken up to 10 times. Pre-requisite: Enrollment on AFROTC
Corequisite(s): AS 2944
Instructional Contact Hours: (2 Lec, 1 Crd)
Repeatability: up to 10 credit hours

AS 2944 - AFROTC Leadership Laboratory (1 credit)
Experiential learning laboratory that allows cadets to practice and demonstrate mastery of leadership skills essential to an Air Force officer. May be taken eight times. Membership in Virginia Tech Corps of Cadets required.
Corequisite(s): AS 1115, AS 1116, AS 2115, AS 2116, AS 3215, AS 3216, AS 4215, AS 4216
Instructional Contact Hours: (4 Lab, 1 Crd)
Repeatability: up to 8 credit hours

AS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 3215 - Air Force Management and Leadership (3 credits)
Integrated leadership study emphasizing concepts and skills. Motivational and behavioral processes, management, military ethics, communication, and group dynamics. Examines case studies and scenarios.
Prerequisite(s): AS 2116
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 3216 - Air Force Management and Leadership (3 credits)
Integrated leadership study emphasizing concepts and skills. Motivational and behavioral processes, management, military ethics, communications, and group dynamics. Examines case studies and scenarios.
Prerequisite(s): AS 2116
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4215 - National Security Forces in Contemporary American Society (3 credits)
Examines the formulation, organization, and implementation of national security; evolution of strategy; management of conflict; and civil-military interaction. Military profession, officership, and the military justice system. Air Force communication skills.
Prerequisite(s): AS 3216
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4216 - National Security Forces in Contemporary American Society (3 credits)
Examines the formulation, organization, and implementation of national security; evolution of strategy; management of conflict; and civil-military interaction. Military profession, officership, and the military justice system. Air Force communications skills.
Prerequisite(s): AS 3216
Corequisite(s): AS 2944
Instructional Contact Hours: (3 Lec, 3 Crd)

AS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

AS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Apparel, Housing, and Resource Management

Our Website (http://www.ahrm.vt.edu)

Overview

The mission of the Department of Apparel, Housing, and Resource Management is to improve quality of life for individuals, families, and the broader community by creating and extending knowledge in apparel, housing, and resource management. We apply business, consumer, and design perspectives to teaching and learning, research, and outreach.

The AHRM Department includes five majors Consumer Studies, Family and Consumer Sciences, Fashion Merchandising and Design, Property Management, and Residential Environments and Design.

Consumer Studies Major

Career Advisor: G. Cheng

The Consumer Studies major prepares students to enter a variety of careers in the public and private sectors. Central to these careers is the ability to analyze issues and problems from the perspectives of consumers, business, and government. Students learn to reasonably advocate consumer interests and to help consumers improve their well-being. They develop fundamental skills that are used to resolve problems faced by consumers in the market place and the work place.

Graduates enter careers related to consumer affairs, marketing and sales, business management, and human resources. Required courses build a thorough understanding of households in the dual roles of producers and consumers that function within an international economic marketplace affected by government policy and regulation. Students study current events to track changing conditions and public policy. Additional courses develop skills for effectively processing and conveying information. A choice of controlled electives enables a student to tailor study to consumer products and promotion or consumer financial services, and counseling.

Consumer Studies students are provided a variety of learning experiences on- and off-campus. Through involvement with student professional associations, as well as relevant state and national organizations, students can develop leadership and organizational skills and network with active professionals. There are opportunities to relate classroom learning to the "real world" with projects and visits with industry, legislators, and regulators. An individualized study experience, typically an internship related to personal career interests, is required.

Fashion Merchandising and Design Major

Career Advisor: S. Wilmot

Apparel fashion is an exciting and competitive field where designers, product developers, manufacturers and retailers create and merchandise products and services for target customers. The Fashion Merchandising

and Design major prepares students for diverse career opportunities available to graduates of the program. Students may find employment with apparel or textile manufacturers or with a wide variety of retailers and fashion media, including magazines and social media websites. Products in apparel fashion range from fast fashion and haute couture to special-use apparel for athletes and extreme sports to accessories and shoes. Graduates from the FMD major may be employed in the areas of product development and/or merchandising. Positions in merchandising include:

- assistant buyer,
- buyer,
- fashion journalist,
- internet merchant,
- merchandise manager,
- showroom manager,
- store manager, and
- visual merchandiser.

Positions in design and product development include:

- creative designer,
- technical designer,
- private label manager,
- sourcing analyst, and
- production manager.

The FMD curriculum is structured to build students' knowledge and skills in the design, development, production, marketing, sale, and use of apparel and other textile products. Individuals employed in today's fashion world need to understand both product design and development and merchandising management. In addition, students learn details about the business and economics of the textile and apparel industry and the cultural and historic aspects of apparel fashion. Supporting courses in accounting or statistics, management, and marketing enhance career preparation.

Many courses in the FMD major promote hands-on learning so that students gain industry type experiences in product development, computer-aided design, textile and apparel evaluation, merchandise planning, promotion, and consumer patronage behavior. Through coursework, internships, study tours, student organizations, and interaction with industry experts, students become prepared to enter the dynamic apparel fashion field.

Property Management Major

Career Advisor: K. Avery

Property management offers a fast-growing career encompassing positions in luxury and affordable apartment developments, senior living communities, mixed-use, and office and retail properties. Hundreds of management positions are available each year, and graduates of Virginia Tech's program are in great demand because they are equipped with skills that address the complexities of managing multimillion-dollar investments. Employment is available in various aspects of the industry including management, operations, marketing, human resources, training, development, and acquisitions.

The property management major offers a wide-ranging program of study that includes specific courses in property management, as well as supporting courses in housing, business, and real estate. All students complete at least one internship that is typically a paid internship with housing provided. The internships give students an opportunity to gain real-world experience, make valuable career contacts, and explore different aspects of property management. Property management's very active advisory board visits campus twice yearly, and many also attend the property management career fair held on campus each March. Board members act as mentors and provide financial support for field trips, professional development, and scholarships. Property management seniors take the National Apartment Association's Certified Apartment Manager exam. Graduating with this credential places new employees a year or more ahead of other entry-level peers.

Residential Environments and Design Major

Career Advisor: G. Galford

The Residential Environments and Design (RED) major focuses on the planning, design, and marketing of residential environments. Required courses emphasize design, human, social, and business factors, including current issues and practices, which influence the environment of housing. The diversity of the population with differing needs, the range of available products, the growth of regulation, the increased concern for health and safety, and the rapid changes in technology are among the factors that lead to a very complex marketplace in the residential industry.

There are many career opportunities for graduates of the RED major, which provide employment as well as business opportunities. Employment opportunities include certified kitchen and bath designers, manufacturing and sales of residential products, residential construction, home furnishings, appliances, and related industries. The future looks bright for those students who choose careers in the residential design industry. A number of trend and demographic indicators suggest that people will continue to spend money on their homes and need products and services from experts. There will be a strong, on-going need in the residential industry for well-educated professionals with specialized knowledge in design and the ability to think and solve complex problems.

The RED major's program in kitchen and bath design is accredited by the National Kitchen and Bath Association, and interested students can prepare to sit for the first level design certification examination. Students in the major are mentored by industry members of the Residential Environments and Design Industry Board. Classroom learning is expanded through field trips, guest speakers, community clients, internships, competitions, and other special projects.

- Consumer Studies Major (p. 966)
- Fashion Merchandising and Design Major (p. 968)
- Property Management Major (p. 969)
- Residential Environments & Design Major (p. 971)

Department Head: Lisa M. Tucker [2,3,7]
Professors: L.M. Tucker [2,3,7], H.I. Chen-Yu, P.J. Fisher, and D.H. Kincade
Associate Professors: E.Z. Hopkins, E. Hwang, J.E. Lee, I.E. Leech, and E. Shin
Assistant Professors: J. Yoo, G.A. Galford, E. Shin, and D.C. Smith-Glaviana
Collegiate Assistant Professor: G. Cheng
Associate Professor of Practice: K. Avery
Assistant Professor of Practice: R. Walsh and S. Wilmot
Visiting Assistant Professor: M. Gawrys

Instructors: H. Illahe

Footnotes:

[1] Award for Excellence in Undergraduate Advising
[2] Academy of Teaching Excellence inductee
[3] Wine Award recipient
[4] Sporn Award recipient
[5] Alumni Award for Extension Excellence
[6] Alumni Award for Research Excellence
[7] Alumni Award for Teaching Excellence
[8] Academy of Faculty Service
[9] Commonwealth of Virginia Outstanding Faculty Award
[10] Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (AHRM)

AHRM 1014 - Design and Art for Consumers (3 credits)
Overview of art and design principles and elements with a focus on their application in the creation and promotion of apparel, housing, and residential technology products for diverse consumers. Review of historical art and design trends and theories in relation to these products. Interpretative strategies and methodologies in visual art and design. Exploration of the design process, including examinations of human factors and user needs.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AHRM 1104 - Introduction to AHRM and Student Resources (1 credit)
Introduction to the Department of Apparel, Housing, and Resource Management (AHRM), majors and curriculum requirements. Introduces students to experiential learning opportunities, undergraduate research, and career opportunities. Exploration of programs and services to enhance awareness of opportunities and support systems available for student success.
Instructional Contact Hours: (1 Lec, 1 Crd)

AHRM 2014 - Design for Consumers Studio (3 credits)
Exploration and application of design principles and elements in two-dimensional and three-dimensional designs that support the development and promotion of products for diverse consumers, including apparel, housing, residential technologies. Application of skills, tools, and methods to the creation of design. Utilization of the design process to develop plans for consumer products for diverse users. Design Lab/Studio.
Prerequisite(s): AHRM 1014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (0 Lec, 5 Lab, 3 Crd)

AHRM 2404 - Consumer Rights (3 credits)
Role of consumers in society and in national and international markets. Consumer rights, responsibilities, policies, regulations and redress. Consumer decision making and planned buying. Current consumer issues such as: product safety, food, health care, housing, environmental impact, banking, credit and insurance from an intercultural perspective.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

AHRM 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

AHRM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CONS)

CONS 2304 - Consumer and Family Finances (3 credits)
Overview of consumer and family finances, including budgeting, goal setting, cash management, credit, insurance, taxes, housing, investment alternatives, and retirement plans. Fundamental tools for financial decision making through the coverage of time value of money, calculations for consumer loans, and tools for financial decisions across the lifecycle. Explore ethical issues surrounding financial decisions.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2974H - Indepdendent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 3404 - Consumer Education Strategies (3 credits)
Analysis of the role of effective consumer education strategies in consumer decision-making. Planning, developing, testing, and evaluating consumer education programs using a variety of strategies, including social marketing, for selected community partners and operating the Consumer Education Laboratory.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

CONS 3504 - Resource Management for Individuals and Families (3 credits)
Introduction to resource management concepts and theories with application to personal and family life goals. Discussion of values, goals, decision making, planning, and communication in relation to the management process. Application of the management process to the use of resources, time, finances, stress, and the environment.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4304 - Advanced Consumer Family Finances (3 credits)
Advanced financial topics for consumers and families. Identification of employee benefit components including health care, incentive plans, insurance, and retirement. Analysis of consumers insurance needs. Discussion and comparison of retirement and investment tools used by consumers, including public and private retirement components. Interpretation of research directions and policy influences related to employee benefits, insurance, investments, and retirement saving. Investigation of special topics in retirement. Pre: Senior Standing.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4314 - Debtor-Creditor Relationships (3 credits)
Examination of legal and operational aspects of debtor-creditor relationship from the perspective of businesses and debtors. Overview of the types of credit, access to credit, factors contributing to debt problems, and alternatives available for resolution. Focus on collection processes of federal and state bankruptcy laws and regulations.
Prerequisite(s): CONS 2304 and AHRM 2404
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4324 - Financial Counseling (3 credits)
Examination of debt and budgeting problems affecting families. Utilizes a problem-solving approach. Includes financial counseling strategies for coping with financial crises and becoming proactive in family financial management.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4404 - Consumer Protection (3 credits)
Analysis of the effectiveness of consumer protection efforts. Examination of government laws, regulations, and agencies at the federal, state, and local levels, as well as the effectiveness of both business and private consumer protection efforts.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4414 - Professionalism in Consumer Affairs (3 credits)
Roles, functions and responsibilites of consumer affairs professionals employed in business, government, and non-profit public/consumer interest organizations. Professional advocacy within employing organizations, managing consumer complaint handling systems and major consumer and career issues are analyzed.
Prerequisite(s): AHRM 2404 and CONS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

CONS 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CONS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (FCS)

FCS 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FCS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (FMD)

FMD 1204 - Clothing and People (3 credits)
The study of the influence of culture and society on dress and dress practices, similarities and differences in the dress among groups and individuals, and the role of dress in reflecting and shaping intra- and inter-cultural interactions. The analysis of the construction and communication of personal and social identity (based on age, physical disability, gender, sex, sexual identity, race, ethnicity, religion, cultural and group/subcultural affiliations, etc.) through dress (clothing, accessories, body modifications) using fashion and social science theories and the intersection of various identities and positions in shaping human experience related to dress and appearance. Examination of diversity, equity, inclusion, and social justice issues and solutions related to dress and appearance within the United States and the global fashion industry.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 1224 - Introduction to the Fashion Industry (3 credits)
Development, structure and operations of textile and apparel manufacturers, marketers and retailers in the fashion industry and the product types including menswear, womenswear, childrenswear and accessories. Identification of fashion careers and major fashion markets and vendors both domestic and international. Basic processes and principles governing forecasting fashion acceptance, movement and change as influenced by economic, sociological, psychological, political and technological factors. Sources of industry information such as trade journals, industry websites and company publications.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 2014 - Digital Drawing (3 credits)
Basic principles and methods for digital drawing with consideration toward diverse populations in the global marketplace. Practice and skill development using a variety of computer tools to express design ideas via digital rendering by targeting diverse populations and understanding current global challenges. Hands-on experience via design projects.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 2204 - Introduction to Textiles (3 credits)
Structure, properties and basic production of textiles and textile components: natural and manufactured fibers; yarns; woven, knit, nonwoven fabrics; mechanical and chemical finishes; colorants and coloration methods. Influence on performance of apparel and interior textile products. Sophomore standing and one semester of Pathways Concept 4 (Reasoning in the Natural Sciences) is required.
Corequisite(s): FMD 2214
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 2214 - Apparel Textiles Laboratory (1 credit)
Identification and characterization of textiles and textile components including: fabrics, finishes and coloration. Influence of these structural parameters on performance of apparel textiles. Sophomore standing and one semester of Pathways concept 4 (Reasoning in the Natural Sciences).
Corequisite(s): FMD 2204
Instructional Contact Hours: (3 Lab, 1 Crd)

FMD 2224 - Fashion Presentation Techniques (3 credits)
Basic principles and methods for executing fashion illustrations, proportions of the fashion figure, design details, portfolio development, identifying target markets and fabric renderings with consideration toward diverse populations in the global marketplace. Exploration and practice in color with work in pencil, color pencil, pastel, and watercolor. Practice and skill development using a variety of manual and computer tools to illustrate construction details and create technical flats. Emphasis placed on the use of correct industry terminology.
Prerequisite(s): AHRM 1014
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 2264 - Apparel Product Development (3 credits)
Study of the pre-production stage of product development in the apparel industry, including planning a line based on market, consumer, and product research, forecasting trends in color, style and materials, developing and selecting designs and styles, and wholesale marketing of a line to retail buyers. Also includes the use of diverse inspiration sources for creating a design, application of computer-aided design to design and style development, and identification of career opportunities and qualifications for professional positions in the industry. Sophomore Standing required.
Prerequisite(s): FMD 2224
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 3024 - History of Costume (3 credits)
Study of the evolution and development of Western costume for adults and children from ancient times to the present with a focus on historical, socio-cultural, political, economic, and psychological factors/influences on changes in fashion and design style features. Use of terminology to describe each period's fashion and clothing design style features. Evaluation of similarities and differences between fashion and clothing design style features of different time periods. Discussion of theories of fashion change and fashion revival theories that explain the revival/reoccurrence of features of historic costume styles in contemporary fashion and design.
Prerequisite(s): FMD 1204 and FMD 2204
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3034 - Historic Costume and Textile Collection Management (3 credits)
An active learning approach to managing and digitizing historic costume and textile collections; conserving historic textiles; and designing and curating historic costume and textile exhibitions. Researching, documenting, interpreting, handling and storing artifacts. Mounting and displaying a professional costume and textile exhibit appropriate for general public viewings and sharing via oral or poster presentations. Community-engagement methods. Design Lab/Studio
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 3104 - Fashion Retailing Concepts (3 credits)
Detailed investigation and analysis of the fundamentals of fashion merchandising concepts emphasizing problem solving at the retail level. Prerequisite: one semester of Pathways Concept 5 (Quantitative and Computational Thinking) required. Pre: Junior Standing.
Prerequisite(s): FMD 1224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3204 - Introduction to Textile Evaluation (3 credits)
Analysis of the performance properties of fabrics. Importance of evaluation to product development, quality control, and specification of care requirements.
Prerequisite(s): FMD 2204 and FMD 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3224 - Apparel Assembly (3 credits)
Systematizing and assembling garment applications for the apparel industry. Conceptual study of simple to complex apparel construction techniques, stitch and seam types, cost-effective measures, applications with manual manipulation, computers, tools, and equipment.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3234 - Pattern Drafting for Apparel (3 credits)
Apparel product development using basic and advanced flat pattern drafting techniques and skills. Concepts and application of specifications, flat pattern drafting techniques, garment fit and alteration, pattern grading, and marker layout principles used in apparel engineering, product development, and production, along with the development of skill in using a variety of related manual and computer tools.
Prerequisite(s): FMD 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FMD 3244 - Small Business Apparel Retail Development (3 credits)
Comprehensive study of small business concepts as applied to the textile and apparel retail industry. Analysis of the entrepreneurial mindset and strategies for business entry with emphasis on small business development, including concept and opportunity identification, merchandising and management, operations and control, advertising and promotion, and financial planning for a textile and/or apparel retail business.
Prerequisite(s): FMD 2264 and FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 3264 - Draping (3 credits)
Study and application of basic and advanced draping techniques for patternmaking in the apparel industry, including darts in skirts and bodices, princess lines in bodices, yokes, pleats and gores in skirts, and asymmetrical structures for whole garments; selection of fabrics appropriate for garment styles; evaluation of garment fit, design and construction. Includes students design and construction of garments suitable for juried design competitions or exhibitions. Design Lab/Studio. Pre: Junior Standing
Prerequisite(s): FMD 3224
Instructional Contact Hours: (5 Lab, 3 Crd)

FMD 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4014 - 3D Digital Apparel Design (3 credits)
Implement design solutions using technologically advanced software to create styling on avatars with photorealistic 3D rendering. Transform skills acquired in digital illustration and flat pattern drafting courses into comprehensive tools to create real-life simulated garments. Manipulate or create digital assets (flat patterns, fabric, stitching, trim, etc.) to produce an original style for digital portfolio. Design Lab/Studio (2H, 2L,3C)
Prerequisite(s): FMD 2264 and FMD 3234
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 4024 - Portfolio (3 credits)
The development and production of a professional apparel portfolio in both paper and ePortfolio format. Pre: Senior Standing required; 3234 or permission of the instructor.
Prerequisite(s): FMD 3234 or FMD 3264
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4034 - Historic Costume and Textile Collection Management (3 credits)
An active and experiential learning approach to historic costume and textile collection management, including describing collection scope, policies, and organizational systems, selecting appropriate basic preservation and conservation techniques used for the care of historic clothing and textiles related to controlling the environment, handling and storage, and cleaning, using standard museum practices when accessioning, dating, labeling, cataloging, mounting/mannequin dressing, and photographing textile artifacts, developing methods for community engagement, and designing and installing historic dress exhibitions. Design Lab Studio.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

FMD 4124 - Clothing Behavior Patterns (3 credits)
Study of clothing behavior of individuals in relationship to their needs, values, attitudes, interests, and self-concepts. Overview of principles and theories related to individuals emotional, mental, and physical activities when obtaining, using, maintaining, and disposing of apparel products so as to satisfy their needs and desires. Application of principles and theories related to clothing behavior to the analysis of consumer and the development of effective merchandising strategies.
Prerequisite(s): FMD 3104 and (PSYC 1004 or SOC 1004)
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4134 - Fashion E-Tailing (3 credits)
Analysis of technologies, consumer trends, and strategies in fashion e-tailing. Identification of merchandising models, major features, challenges, and trends in fashion e-tailing, including big data, virtual and augmented technologies, and mobile- and social-commerce. Development of a strategic plan for an online fashion venture.
Prerequisite(s): FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4214 - Economics of the Textile and Apparel Industry (3 credits)
Study of the various segments of teh textile and apparel industry. Analysis of the market structure and functioning of each segment and of factors currently affecting the industry.
Prerequisite(s): (AHRM 2204 or FMD 2204) and (ECON 2006 or ECON 2006H) or (AAEC 1005 and AAEC 1006)
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4224 - Fashion Analysis and Communication (3 credits)
Functions of fashion analysis, promotions, forecasting, media, and communications in the fashion industry. Assessment of effective promotional activities based on consumer, market, and trend research of fashion products. Development of fashion promotion, forecasting, and communication plans. Pre: Senior standing.
Prerequisite(s): FMD 2264
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

FMD 4234 - Apparel Quality Evaluation (3 credits)
Study of quality of ready-to-wear apparel and factors that influence variations in the aesthetic and functional performance of the end product, including consumer perceptions and expectations, manufacturing processes and trends, and the physical components of the end product.
Prerequisite(s): FMD 3204 and FMD 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4244 - New York Fashion Study Tour (3 credits)
Integrative study of methods of operating at all levels within the fashion industry. Special emphasis on design, merchandising, and promotional activities. Seminars on campus and at pre-arranged appointments during a five-day stay in New York. AHRM major; Junior standing. Twelve hours of AHRM/FMD courses required.
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4264 - Fashion Merchandising and Design Strategies (3 credits)
Analysis of consumer characteristics as part of a forecast/market study to prepare new fashion merchandise lines based on key findings from forecasts. Formulate a financial merchandise plan using measures of profitability and pricing and devise financially beneficial marketing communications. Compare and contrast career choices through self-evaluation within the fashion apparel industry.
Prerequisite(s): FMD 3104 and FMD 3204 and FMD 3224 and FMD 4224
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4274 - International Sourcing of Apparel Products (3 credits)
Study of international sourcing of apparel products through a simulation of the sourcing production to illustrate the procedures and factors needed to source apparel abroad and interrelationships among suppliers, retailers and consumers in the global apparel supply chain. Examination of social, economic, political, cultural, ethical, and environmental factors, law and trade barriers that influence a sourcing decision of apparel products abroad.
Prerequisite(s): FMD 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

FMD 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4964H - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FMD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (PM)

PM 2664 - Introduction to Property Management (3 credits)
The history of residential and commercial property management, roles and responsibilities of real estate managers, developing effective management plans for properties, maintenance strategies, marketing, legal regulations that pertain to real estate management.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 2684 - Marketing and Leasing Residential Properties (3 credits)
Marketing and leasing functions for multifamily residential properties. Leasing processes, options, and online management tools. Market analysis. State and federal housing laws. Preparation for National Apartment Leasing Professional credentials.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 3634 - Managing Affordable and Specialized Housing (3 credits)
Operations management of specialized housing such as senior apartments, active adult communities, independent living communities, assisted living communities, nursing homes, affordable housing, military housing, student housing, as well as community associations and mixed-use housing developments. Consideration of consumer lifestyles, financial circumstances, and sustainability issues for each housing option.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3674 - Property Management Operations (3 credits)
Detailed investigation and analysis of the fundamentals of property management operation functions. Functions included: human resources and relationship management, maintenance and risk management, marketing and leasing, and accounting and finance. Property manager and property owner role interpretation through examination of management agreement and plan components as well as nuances among residential properties, office buildings, and shopping centers.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3684 - Sustainable Property Management (3 credits)
Comparison and justification of green alternatives during the operations and maintenance phase of the building lifecycle by function with respect to the interrelationships of the social, environmental, and economic spheres of sustainability. Course topics also include group and individual decision-making and their influences on resource use such as energy, water, and waste as well as environmental degradation concern and its influence on various stakeholders and their relationship with each other. Ethical issues as they relate to sustainable property management also covered.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4644 - Advanced Property and Asset Management (3 credits)
Examination of the competencies necessary to maximize the value of real estate assets through effective operations and financial management practices. Includes detailed examination of income maximization, financial reporting, and ownership objectives of real estate investors.
Prerequisite(s): (PM 2674 or PM 3674) and PM 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4674H - Managing and Marketing Housing for Later Life (2 credits)
Managing and marketing housing for later life, including active adult communities and assisted living facilities. Pre: Junior Standing
Instructional Contact Hours: (2 Lec, 2 Crd)

PM 4684 - Leasing Commercial Properties (3 credits)
Examination of the strategies used to market and lease various types of industrial, office and retail buildings with emphasis placed on brokerage relationships, the legal structure of commercial real estate leases, lease analytics, lease negotiations, and the impact of lease terms on the value of income-producing properties. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4694 - Contemporary Issues in Property Management (3 credits)
Issues affecting property management, including ethics, professional management decisions, legislative issues, and current management practices. The course culminates in the analysis of an apartment community and development of a management plan. Senior standing.
Prerequisite(s): PM 4964 or PM 4644
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4744 - Housing Challenges and Policies in the United States (3 credits)
Overview of the issues relating to U.S. housing policy with an emphasis on housing affordability, homeownership, fair housing and community development, and homelessness. Examination of the policy tools used to respond to housing problems at local, state and federal levels.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PM 4914 - Residential Property Management Study Tour (1-19 credits)
Study tour that examines trends in the multifamily housing industry focusing on marketing, management, design, and customer service. Variable credit 2 credits maximum.
Instructional Contact Hours: Variable credit course

PM 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (RED)

RED 1604 - Introduction to Residential Design (3 credits)
Analysis of residential spaces to meet the needs of residents. Interrelationship of residential spaces, site, and community, including climate, historic tradition, culture and impact on diversity. House construction systems and finish materials. Current and future trends in design, construction and marketing of housing for diverse households. Impact of codes and regulations on residential design and construction. Professional and labor force issues in the housing industry, interpreting residential floor plans, elevations, detail drawings.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2234 - Residential Materials (3 credits)
Identifies materials used in residential applications. Flooring, Walls, Ceilings, Trim and Textiles. Reviews properties of materials, wellness for occupants, and sustainability criteria.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2614 - Residential Construction (3 credits)
Principles of residential construction. Components, materials and methods of residential construction. Terminology used in residential construction. Interior detailing.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2624 - Residential Design I (3 credits)
Principles of residential design. Concept development using elements and principles of design. Space planning for residential environments including kitchen and bath design. Introduction to hand and computer drawing. Design Lab/Studio.
Prerequisite(s): RED 1604 or RED 2604
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 2644 - Housing and the Consumer (3 credits)
Overview of housing as it relates to consumer needs, values, lifestyles, norms and constraints. Includes structural and tenure alternatives, financial and legal considerations, house design, neighborhood choices, the home buying process, and future directions in housing. Government aspects focus on the history of federal involvement in housing, major housing programs, role of state and local government, and current housing issues and policies.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 2654 - Residential Environments (3 credits)
Application of elements and principles of design in residential spaces and products from diverse cultural perspectives. Examination of human behavior theories that impact the design of residential environments. Development of residential design solutions and processes using computer aided design software. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

RED 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 3624 - Residential Design II (3 credits)
Principles of space planning and 3-dimensional design, including activity analysis and user needs, program preparation as applied to residential settings. Zoning and space planning. Design process including schematic design and design development. Design detailing. Graphic design solutions for specific areas of the home, including social, private, kitchen, and outdoor areas. Design Lab/Studio.
Prerequisite(s): RED 2624 and RED 1624
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 3644 - American Housing (3 credits)
Overview of the role of housing in family life and society throughout the history of the United States. Exploration of the impact of technology, resources, and societal values on the design and style of housing and products used in the home.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 3674 - Residential Systems (3 credits)
Residential systems such as lighting, plumbing, electrical, mechanical and security. Smart home technologies and appliances. Integration of systems into residential environments.
Prerequisite(s): RED 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4224 - Historic Preservation of Residential Properties (3 credits)
History, theory, and field methods of historic preservation in the United States such as building and site surveys, historic structures reports, and National Register Nominations; history and theory of European preservation; fundamental concepts and the role of preservation in allied disciplines; preservation in urban, town, neighborhood, and rural contexts; common preservation strategies and initiatives; understanding of community-based preservation efforts; focus on residential properties.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4604 - Environmental and Sustainability Issues in Housing (3 credits)
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4604H - Environmental and Sustainability Issues in Housing (3 credits)
Environmental and sustainability issues in single and multifamily housing in the United States encompassing the building, site, lifestyle, energy and water consumption, waste, air quality and toxic materials; analysis and application of social science theories and equity and identity concerns that provide a foundation for the study of environmentally sustainable housing; current and future alternatives for management of energy and water systems and provision of environmentally sustainable housing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4624 - Residential Design III (3 credits)
Planning, design, and evaluation of residential spaces with an emphasis on kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people. Industry standards, best practices. Materials, fixtures, and mechanical systems. Contract documents. Design Lab/Studio.
Prerequisite(s): RED 3624
Instructional Contact Hours: (5 Lab, 3 Crd)

RED 4624H - Advanced Kitchen and Bath Design (3 credits)
Planning, design, and evaluation of residential kitchens and bathrooms, in relation to the total house plan. Emphasis on planning principles and technical requirements with attention to functional use of the spaces to meet the needs of people.
Prerequisite(s): (AHRM 3624 or RED 3624) and (AHRM 3674 or RED 3674)
Instructional Contact Hours: (6 Lab, 3 Crd)

RED 4654 - Residential Design IV (3 credits)
Advanced topics in house planning, particularly kitchen and bath design, with emphasis on independent work of portfolio quality. Sustainability principles, design process, planning guidelines, design competition. May be repeated once for a maximum of 6 credits. Design Lab/Studio (5L,3C)
Prerequisite(s): RED 4624
Instructional Contact Hours: (5 Lab, 3 Crd)
Repeatability: up to 6 credit hours

RED 4664 - Universal Design (3 credits)
Application and assessment of the principles and strategies of universal design in residential and commercial environments, accessibility regulations and guidelines, products, and technologies. Demographic changes affecting global society. Disabilities and changes throughout the lifespan that affect peoples ability to interact with their environments. Marking strategies to promote universal design communities, products, environments and technologies. Methodologies to evaluate accessibility.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RED 4664H - Universal Design (2 credits)
Evaluation and design of commercial and residential environments with consideration for accessibility, adaptation, safety, and support of the user(s).
Instructional Contact Hours: (2 Lec, 2 Crd)

RED 4764 - Universal Design Lab (1 credit)
Design of residential spaces that meet the needs of a range of users, including older adults and people with disabilities. Principles of universal design are applied to the spatial requirements and product selection for the home.
Prerequisite(s): AHRM 3624 or RED 3624
Corequisite(s): RED 4664
Instructional Contact Hours: (2 Lab, 1 Crd)

RED 4924 - Housing Study Tour (1-19 credits)
A study tour designed to examine the housing industry and trends in design, technology, products and processes. Junior standing required. May be repeated for a maximum of 6 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 6 credit hours

RED 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4964H - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RED 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Consumer Studies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AHRM 1104	Introduction to AHRM and Student Resources [1]	1
Economic Well-Being		
AHRM 2404	Consumer Rights [2]	3
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	6
or AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Product Analysis		
Select one of the following:		3
CONS 3504	Resource Management for Individuals and Families (required for CONS major) [2]	
FMD 1204	Clothing and People	
RED 2644	Housing and the Consumer	
Business Fundamentals		
MKTG 3104	Marketing Management	3
Action Learning		
Select one of the following:		3
CONS 4964	Field Work/Practicum [2]	
CONS 4974	Independent Study [2]	
CONS 4994	Undergraduate Research [2]	
FMD 4244	New York Fashion Study Tour	
Subtotal		19
Major Requirements		
CONS 3404	Consumer Education Strategies [2]	3
CONS 4304	Advanced Consumer Family Finances [2]	3
CONS 4314	Debtor-Creditor Relationships [2]	3
CONS 4324	Financial Counseling [2]	3
CONS 4404	Consumer Protection [2]	3
CONS 4414	Professionalism in Consumer Affairs [2]	3
COMM 2004	Public Speaking	3
ACIS 1004	Accounting Foundations	3
MGT 3304	Management Theory and Leadership Practice	3
Subtotal		27
Controlled Electives		
Select at least 15 credits from the list below:		15
AAEC 3454	Small Business Management and Entrepreneurship	
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
CONS 4974	Independent Study	
CONS 4994	Undergraduate Research	
CRIM 3414	Criminology	
FIN 2114	Investments and Financial Literacy	
FIN 3054	Legal and Ethical Environment of Business	
FIN 3124	Financial Planning for Professionals	
FIN 3204	Risk and Insurance	
HD 2304	Family Relationships	
HNFE 1004	Foods, Nutrition And Exercise	
MGT 3064	Cornerstones of Entrepreneurship and Innovation	
MGT 3324	Organization Behavior	
MGT 3334	Managing Human Resources	
MKTG 3504	Advertising	
MKTG 4154	Marketing Research	
MKTG 4204	Consumer Behavior	
PHS 1514	Personal Health	
PHS 3534	Drug Education	
PSCI 1014	Introduction to United States Government and Politics	
PSCI 1024	Comp Gov & Politics	
PSCI 3224	Public Opinion	
PSCI 3264		
RED 2614	Residential Construction	
RED 2644	Housing and the Consumer	
Subtotal		15
Free Electives		
Select 14 credits of Free Electives		14
Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1F) [1]	6
Select one course from the options below for Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) :		3
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
HD 1004	Childhood and Adolescence [1]	3
HD 2004	Adulthood and Aging	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		

CONS 2304	Consumer and Family Finances (5F) [1,2]	3
MATH 1014	Precalculus with Transcendental Functions (5F) [1]	3
or MATH 1025	Elementary Calculus	
or MATH 1524	Business Calculus	
STAT 3604	Statistics for Social Science (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
AHRM 1014	Design and Art for Consumers [1]	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) or Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 For satisfactory progress toward a degree, these courses must be completed by the time the student has attempted 75 hours.

2 Courses included in in-major GPA calculation; in-major and overall GPA of 2.0 required for graduation.

Satisfactory Progress Toward Degree

Students must complete the courses listed to equal at least 120 credits, with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. Courses included in the calculation of **in-major** GPA are notated with the applicable footnote.

Graduation Requirements

Credit Hour Requirement

A total of 120 hours is required to graduate with a Consumer Studies degree.

Prerequisites

Some courses required for this major have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign language courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credit hours of foreign language have been earned. These credits do not count toward graduation.

First Year		
Fall Semester		**Credits**
ENGL 1105	First-Year Writing (1F)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
HD 1004	Childhood and Adolescence	3
MATH 1014 or MATH 1025 or MATH 1524	Precalculus with Transcendental Functions or Elementary Calculus or Business Calculus	3
AHRM 1104	Introduction to AHRM and Student Resources	1
AHRM 2404	Consumer Rights	3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
CONS 2304	Consumer and Family Finances	3
AHRM 1014	Design and Art for Consumers	3
HD 2004	Adulthood and Aging	3
	Credits	**15**
Second Year		
Fall Semester		
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
COMM 2004	Public Speaking	3
CONS 3504	Resource Management for Individuals and Families	3
Controlled Elective		3
Controlled Elective		3
	Credits	**15**
Spring Semester		
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
ENGL 3764 or ENGL 3774	Technical Writing or Business Writing	3
CONS 3404	Consumer Education Strategies	3
Controlled Elective		3
Controlled Elective		3
	Credits	**15**
Third Year		
Fall Semester		
Pathways Concept 2 - Critical Thinking in the Humanities		3
STAT 3604	Statistics for Social Science	3
CONS 4314	Debtor-Creditor Relationships	3
MGT 3304	Management Theory and Leadership Practice	3
Free Elective		3
	Credits	**15**
Spring Semester		
Pathways Concept 2 - Critical Thinking in the Humanities		3
MKTG 3104	Marketing Management	3
Controlled Elective		3
CONS 4304	Advanced Consumer Family Finances	3
	Credits	**12**
Summer Semester		
CONS 4964 or CONS 4974 or CONS 4994	Field Work/Practicum or Independent Study or Undergraduate Research	3
	Credits	**3**
Fourth Year		
Fall Semester		
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
ACIS 1004	Accounting Foundations	3
CONS 4404	Consumer Protection	3
Free Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
CONS 4324	Financial Counseling	3
CONS 4414	Professionalism in Consumer Affairs	3
Free Elective		3
Free Elective		2
	Credits	**14**
	Total Credits	**120**

Fashion Merchandising and Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AHRM 1104	Introduction to AHRM and Student Resources	1
Economic Well-Being		
AHRM 2404	Consumer Rights	3
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	6
or AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Product Analysis		
Select one of the following:		3
FMD 1204	Clothing and People (required for FMD majors)	
CONS 3504	Resource Management for Individuals and Families	
RED 2644	Housing and the Consumer	
Business Fundamentals		
MKTG 3104	Marketing Management	3
Action Learning		
Select one of the following:		3
FMD 3954	Study Abroad	
FMD 4244	New York Fashion Study Tour	
FMD 4964	Field Work/Practicum	
FMD 4974	Independent Study	
FMD 4994	Undergraduate Research	
Subtotal		19
Major Requirements		
FMD 1224	Introduction to the Fashion Industry	3
FMD 2204	Introduction to Textiles	3
FMD 2214	Apparel Textiles Laboratory	1
FMD 2264	Apparel Product Development	3
FMD 3024	History of Costume	3
FMD 3104	Fashion Retailing Concepts	3
FMD 3204	Introduction to Textile Evaluation	3
FMD 3224	Apparel Assembly	3
FMD 4224	Fashion Analysis and Communication	3
FMD 4234	Apparel Quality Evaluation	3
FMD 4264	Fashion Merchandising and Design Strategies	3
FMD 4274	International Sourcing of Apparel Products	3
MGT 3304	Management Theory and Leadership Practice	3
Subtotal		37
Controlled Electives		
Select three of the following:		9
FMD 2014	Digital Drawing	
FMD 3034	Historic Costume and Textile Collection Management	
FMD 3234	Pattern Drafting for Apparel	
FMD 3264	Draping	
FMD 4014	3D Digital Apparel Design	
FMD 4124	Clothing Behavior Patterns	
FMD 4134	Fashion E-Tailing	
Select one of the following:		3
ACIS 2115	Principles of Accounting	
AHRM 2014	Design for Consumers Studio	
CONS 3404	Consumer Education Strategies	
CONS 4314	Debtor-Creditor Relationships	
CONS 4404	Consumer Protection	
MGT 3324	Organization Behavior	
MKTG 3504	Advertising	
MKTG 4204	Consumer Behavior	
MKTG 4554	Principles of Professional Selling	
MKTG 4604	Retail Management	
Subtotal		12
Free Electives		
Select remaining credits to fulfill degree requirements.		7
Subtotal		7
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing	6
or COMM 1015 & COMM 1016	Communication Skills and Communication Skills	
Select three credits in Pathway 1A		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		
SOC 1004	Introductory Sociology	3
or PSYC 1004	Introductory Psychology	
Select three credits in Pathway 3		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following (5F):		
ACIS 1004	Accounting Foundations	3
or CONS 2304	Consumer and Family Finances	
or STAT 2004	Introductory Statistics	
Select three credits in Pathway (5F or 5A)		3
Select three credits in Pathway (5A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
AHRM 1014	Design and Art for Consumers (6A)	3
FMD 2224	Fashion Presentation Techniques (6D) [2]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] For satisfactory progress toward a degree, these courses must be completed by the time the student has attempted 72 hours.
A sequence of 2 foreign language courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See Catalog section on "Graduation Requirements.

[2] Courses included in in-major GPA calculation; in-major and overall GPA of 2.0 required for graduation.

In accordance with University guidelines, courses satisfying Degree Core Requirements may not be double counted to satisfy other areas of a degree such as in Pathways, Major Requirements, etc.

Satisfactory Progress Toward Degree

Students must complete the courses listed to equal at least 120 credits, with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. Courses included in the calculation of **in-major** GPA are notated with the applicable footnote.

Graduation Requirements

Credit Hour Requirement

A total of 120 hours is required to graduate with a Fashion Merchandising and Design degree.

Prerequisites

Some courses required for this major have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign language courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credit hours of foreign language have been earned. These credits do not count toward graduation.

First Year		
Fall Semester		**Credits**
ENGL 1105	First-Year Writing	3
SOC 1004 or PSYC 1004	Introductory Sociology or Introductory Psychology	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
AHRM 1014 or FMD 1224	Design and Art for Consumers or Introduction to the Fashion Industry	3
FMD 1204	Clothing and People	3
AHRM 1104	Introduction to AHRM and Student Resources	1
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
ACIS 1004 or CONS 2304 or STAT 2004	Accounting Foundations or Consumer and Family Finances or Introductory Statistics	3
FMD 1224 or AHRM 1014	Introduction to the Fashion Industry or Design and Art for Consumers	3
AHRM 2404	Consumer Rights	3
	Credits	**15**
Second Year		
Fall Semester		
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
FMD 2224	Fashion Presentation Techniques	3
FMD 2204	Introduction to Textiles	3
FMD 2214	Apparel Textiles Laboratory	1
	Credits	**16**
Spring Semester		
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
FMD 2264	Apparel Product Development	3
FMD 3224	Apparel Assembly	3
Free Elective		3
	Credits	**15**
Third Year		
Fall Semester		
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
MGT 3304	Management Theory and Leadership Practice	3
FMD 3104	Fashion Retailing Concepts	3
FMD 3204	Introduction to Textile Evaluation	3
FMD 3024	History of Costume	3
	Credits	**15**
Spring Semester		
Pathways Concept 1 - Discourse (Advanced)		3
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced)		3
MKTG 3104	Marketing Management	3
Non-FMD Controlled Elective		3
FMD Controlled Elective		3
	Credits	**15**
Fourth Year		
Fall Semester		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
FMD 4224	Fashion Analysis and Communication	3
FMD 4234	Apparel Quality Evaluation	3
FMD Controlled Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
FMD 4264	Fashion Merchandising and Design Strategies	3
FMD 4274	International Sourcing of Apparel Products	3
FMD Controlled Elective		3
Free Elective		1
FMD 3954 or FMD 4974 or FMD 4994 or FMD 4244 or FMD 4964	Study Abroad or Independent Study or Undergraduate Research or New York Fashion Study Tour or Field Work/Practicum	3
	Credits	**13**
	Total Credits	**120**

Property Management Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AHRM 1104	Introduction to AHRM and Student Resources [1]	1
Economic Well-Being		
AHRM 2404	Consumer Rights [2]	3
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	6

or AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Product Analysis		
Select one of the following:		3
FMD 1204	Clothing and People	
CONS 3504	Resource Management for Individuals and Families	
RED 2644	Housing and the Consumer (required for PM major) [2]	
Business Fundamentals		
MKTG 3104	Marketing Management	3
Action Learning		
Select one of the following:		3
PM 3954	Study Abroad	
PM 4964	Field Work/Practicum (required for PM major) [2]	
PM 4974	Independent Study	
PM 4994	Undergraduate Research	
FMD 4244	New York Fashion Study Tour (FMD Majors)	
Subtotal		19
Major Requirements		
RED 2614	Residential Construction [1,2]	3
PM 2664	Introduction to Property Management [1,2]	3
PM 2684	Marketing and Leasing Residential Properties [2]	3
PM 3634	Managing Affordable and Specialized Housing [2]	3
PM 3674	Property Management Operations [1,2]	3
PM 3684	Sustainable Property Management [2]	3
PM 4644	Advanced Property and Asset Management [2]	3
PM 4684	Leasing Commercial Properties [2]	3
PM 4694	Contemporary Issues in Property Management [2]	3
PM 4744	Housing Challenges and Policies in the United States [2]	3
MGT 3304	Management Theory and Leadership Practice	3
Subtotal		33
Controlled Electives		
Select twelve credits from the following list:		12
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
CONS 2304	Consumer and Family Finances	
PM 4914	Residential Property Management Study Tour	
REAL 4064	Real Estate Appraisal	
REAL 4754	Real Estate Law	
SBIO 3324	Green Building Systems	
COMM 2004	Public Speaking	
ENGL 3774	Business Writing	
MKTG 4734	Real Estate Marketing	
REAL 3034	Real Estate Market Analysis	
REAL 3044	Financing Real Estate Projects	
UAP 2004	Principles of Real Estate	
HTM 2464	Designing the Service Experience	
MGT 3334	Managing Human Resources	
MGT 4334	Ethical Leadership and Corporate Social Responsibility	
RED 4664	Universal Design	
Subtotal		12
Free Electives		
Select 11 credits of free electives		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing [1]	6
or COMM 1015 & COMM 1016	Communication Skills and Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		3
SOC 1004	Introductory Sociology	
SOC 2004	Social Problems	
PSYC 1004	Introductory Psychology	
HD 1004	Childhood and Adolescence	
RED 4604	Environmental and Sustainability Issues in Housing [2]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
ACIS 1004	Accounting Foundations [1,2]	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select 3 additional credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) or Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
AHRM 1014	Design and Art for Consumers [2]	3
RED 1604	Introduction to Residential Design [2]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 fulfilled by completing RED 4604.		3
Subtotal		45
Total Credits		**120**

[1] For satisfactory progress toward a degree, these courses must be completed by the time the student has attempted 75 hours.

[2] Courses included in in-major GPA calculation; in-major and overall GPA of 2.0 required for graduation.

Satisfactory Progress Toward Degree

Students must complete the courses listed to equal at least 120 credits, with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. Courses included in the calculation of **in-major** GPA are notated with the applicable footnote.

Graduation Requirements

Credit Hour Requirement

A total of 120 hours is required to graduate with a Property Management degree.

Prerequisites

Some courses required for this major have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign language courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer credit hours of foreign language have been earned. These credits do not count toward graduation.

First Year		
Fall Semester		**Credits**
ENGL 1105	First-Year Writing	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
ACIS 1004	Accounting Foundations	3
AHRM 1104	Introduction to AHRM and Student Resources	1
SOC 1004 or SOC 2004 or PSYC 1004 or HD 1004	Introductory Sociology or Social Problems or Introductory Psychology or Childhood and Adolescence	3
PM 2664	Introduction to Property Management	3
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
AHRM 2404	Consumer Rights	3
AHRM 1014	Design and Art for Consumers	3
	Credits	**15**
Second Year		
Fall Semester		
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
RED 2614	Residential Construction	3
PM 3674	Property Management Operations	3
Free Elective		3
	Credits	**15**
Spring Semester		
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
RED 2644	Housing and the Consumer	3
PM 2684	Marketing and Leasing Residential Properties	3
Free Elective		3
	Credits	**15**
Third Year		
Fall Semester		
Pathways Concept 1 - Discourse (Advanced)		3
MGT 3304	Management Theory and Leadership Practice	3
PM 3684	Sustainable Property Management	3
PM 3634	Managing Affordable and Specialized Housing	3
Free Elective		3
	Credits	**15**
Spring Semester		
MKTG 3104	Marketing Management	3
PM 4684	Leasing Commercial Properties	3
PM Controlled Elective		3
PM Controlled Elective		3
	Credits	**12**
Summer Semester		
PM 4964	Field Work/Practicum	3
	Credits	**3**
Fourth Year		
Fall Semester		
RED 1604	Introduction to Residential Design	3
PM 4644	Advanced Property and Asset Management	3
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced)		3
PM 4744	Housing Challenges and Policies in the United States	3
PM Controlled Elective		3
	Credits	**15**
Spring Semester		
PM 4694	Contemporary Issues in Property Management	3
RED 4604	Environmental and Sustainability Issues in Housing	3
PM Controlled Elective		3
Free Elective		3
Free Elective		2
	Credits	**14**
	Total Credits	**120**

Residential Environments & Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
AHRM 1104	Introduction to AHRM and Student Resources [1]	1
Economic Well Being		
AHRM 2404	Consumer Rights [2]	3
Select one of the following:		6
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Product Analysis		
Select one of the following:		3
CONS 3504	Resource Management for Individuals and Families	
FMD 1204	Clothing and People	
RED 2644	Housing and the Consumer (Required for RED) [2]	
Business Fundamentals		
MKTG 3104	Marketing Management	3
Action Learning		
Select one of the following:		3
RED 4964	Field Work/Practicum (Required for RED) [2]	
RED 4974	Independent Study	
RED 4994	Undergraduate Research	
RED 3954	Study Abroad	
FMD 4244	New York Fashion Study Tour	
Subtotal		19

Major Requirements		
RED 1604	Introduction to Residential Design [1,2]	3
RED 2624	Residential Design I [1,2]	3
RED 2614	Residential Construction [2]	3
RED 2234	Residential Materials [2]	3
RED 2654	Residential Environments [2]	3
RED 3624	Residential Design II [2]	3
RED 3644	American Housing [2]	3
RED 3674	Residential Systems [2]	3
RED 4624	Residential Design III [2]	3
RED 4664	Universal Design [2]	3
RED 4654	Residential Design IV [2]	3
Subtotal		33
Controlled Electives		
Select twelve credits of the following:		12
ART 2385	Survey of the History of Western Art	
IDS 1114	Play to Make	
COMM 2004	Public Speaking	
CONS 2304	Consumer and Family Finances	
HD 1004	Childhood and Adolescence	
HD 1134	Introduction to Disabilities Studies	
HD 2004	Adulthood and Aging	
HD 3114	Issues in Aging	
HTM 3424	Event Management	
HUM 2204	The Creative Process	
HUM/RLCL 3034	Theories of Popular Culture	
IDS 2114	History of Industrial Design	
IDS 2124	History of Modern Industrial Designers	
MGT 2064	Foundations of Entrepreneurship	
MKTG 4204	Consumer Behavior	
MKTG 4554	Principles of Professional Selling	
PM 2664	Introduction to Property Management	
PM 2684	Marketing and Leasing Residential Properties	
PM 3634	Managing Affordable and Specialized Housing	
PM 4744	Housing Challenges and Policies in the United States	
REAL/UAP 2004	Principles of Real Estate	
RED 3954	Study Abroad	
RED 4924	Housing Study Tour	
RED 4994	Undergraduate Research	
SBIO 3324	Green Building Systems	
STS 3284	Technology and Disability	
Subtotal		12
Free Electives		
Select remaining credits of free electives		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1f)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
RED 4224	Historic Preservation of Residential Properties [2]	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
RED 4604	Environmental and Sustainability Issues in Housing (Required for RED major) [2]	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
ACIS 1004	Accounting Foundations (5F ; required for RED) [1]	3
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
AHRM 1014	Design and Art for Consumers (Integrated art and design credit ; required for RED) [1,2]	3
AHRM 2014	Design for Consumers Studio (6D ; required for RED) [2]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
RED 4604	Environmental and Sustainability Issues in Housing (Required for RED) [2]	3
Subtotal		45
Total Credits		**120**

[1] For satisfactory progress toward a degree, these courses must be completed by the time the student has attempted 75 hours.

[2] Courses included in in-major GPA calculation; in-major and overall GPA of 2.0 required for graduation.

Satisfactory Progress Toward Degree

Students must complete the courses listed to equal at least 120 credits, with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00. Courses included in the calculation of **in-major** GPA are notated with the applicable footnote.

Graduation Requirements

Credit Hour Requirement

A total of 120 hours is required to graduate with a Residential Environments and Design degree.

Prerequisites

Some courses required for this major have prerequisites. Please refer to Undergraduate Course Catalog or consult your advisor for information about prerequisites.

Foreign Language Requirement

A sequence of 2 foreign language courses is required for graduation unless 2 high school credits of the same foreign language or 6 transfer

credit hours of foreign language have been earned. These credits do not count toward graduation.

First Year		
Fall Semester		**Credits**
ENGL 1105	First-Year Writing (1F)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
RED 1604	Introduction to Residential Design	3
AHRM 1014	Design and Art for Consumers	3
AHRM 1104	Introduction to AHRM and Student Resources	1
	Credits	**16**
Spring Semester		
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
ACIS 1004	Accounting Foundations	3
AHRM 2404	Consumer Rights	3
RED 2644	Housing and the Consumer	3
	Credits	**15**
Second Year		
Fall Semester		
ECON 2005 or AAEC 1005	Principles of Economics or Economics of the Food and Fiber System	3
Pathways Concept 3 - Reasoning in the Social Sciences		3
AHRM 2014	Design for Consumers Studio	3
RED 2624	Residential Design I	3
RED 2614	Residential Construction	3
	Credits	**15**
Spring Semester		
ECON 2006 or AAEC 1006	Principles of Economics or Economics of the Food and Fiber System	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
RED Controlled Elective		3
RED 2654	Residential Environments	3
RED 2234	Residential Materials	3
	Credits	**15**
Third Year		
Fall Semester		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced)		3
RED 3644	American Housing	3
RED Controlled Elective		3
Free Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
RED 3624	Residential Design II	3
RED 3674	Residential Systems	3
RED Controlled Elective		3
Pathways Concept 1 - Discourse (Advanced)		3
	Credits	**12**
Summer Semester		
RED 4964	Field Work/Practicum	3
	Credits	**3**
Fourth Year		
Fall Semester		
RED 4224	Historic Preservation of Residential Properties	3
RED 4624	Residential Design III	3
RED 4664	Universal Design	3
RED Controlled Elective		3
Free Elective		3
	Credits	**15**
Spring Semester		
RED 4604	Environmental and Sustainability Issues in Housing	3
RED 4654	Residential Design IV	3
MKTG 3104	Marketing Management	3
Free Elective		3
Free Elective		2
	Credits	**14**
	Total Credits	**120**

Army ROTC

Our Website (http://www.armyrotc.vt.edu)

Overview

The Department of Military Science provides a program of leader development which prepares college men and women for service as officers in the United States Army. After graduation, they serve as commissioned officers on active duty, in the Army Reserves, or in the Army National Guard. To accomplish this, the department:

- Prepares Cadets to be commissioned as Second Lieutenants through a curriculum which develops leadership skills and provides opportunities to use these skills in a variety of experiential learning environments.
- Provides an understanding of how to lead and influence small organizations, with a strong emphasis on character, personal integrity, adaptability, critical thinking, innovation, agility, ethical decision making, goal setting, and mission accomplishment.
- Offers individual training including rappelling, land-navigation, marksmanship, and, for selected students, airborne, air assault, or combat diver training. Army sponsored international programs for cultural awareness and language training as well as internships with Army units and federal agencies worldwide are also offered during the summer.
- In conjunction with the Virginia Tech Corps of Cadets, provides programs and experiences which increase self-confidence, self-discipline, physical stamina, resilience, and other attributes essential to the development of a leader of character--one who is prepared to serve the nation or community either in or out of uniform.

The curriculum and leader development programs of the Department of Military Science are mentally and physically challenging. Cadets learn individual soldier skills and participate in physical conditioning for all four years. On-campus instruction is done both in the classroom and in the field environment. Lab training and leadership development exercises expand the general knowledge of Cadets and provide opportunities for practical leadership experience. A six-week leadership development and assessment course (Advanced Camp) is mandatory the summer between junior and senior year; the course is held at Fort Knox, Kentucky.

- Military Science I (freshmen) includes the semesters Introduction to the Army and Foundations of Leadership. Cadets learn about the U.S. Army and the Profession of Arms, with a focus on the Army Values, the Warrior Ethos, and basic leadership and Soldier skills. Later Cadets are introduced to battle drills and squad tactics, critical thinking and communications skills, as well as the Army's model for holistic health and fitness.
- Military Science II (sophomores) includes the semesters Leadership and Ethics and Army Doctrine and Decision Making. In this year, Cadets focus more on leadership and team building, with continued focus on Soldier fundamentals, and a deeper look at Army Values

in the context of ethics and the law of land warfare. Later Cadets are introduced to the Army problem solving process, troop leading procedures, analytical skills, Joint and Army doctrine, and tactical skills at the platoon level.

- Military Science III (juniors) includes the semesters Training Management and the Warfighting Functions and Applied Leadership in Small Unit Operations. Cadets examine and apply the individual and collective leadership skills to lead a platoon formation (up to 40 personnel) and train on giving and receiving peer evaluations, the fundamentals of organizational training management, and how the Army operates through the Warfighting Functions (such as mission command, movement and maneuver and intelligence).
- Military Science IV (seniors) includes the semesters The Army Officer and Company Grade Leadership. This year is the final preparation for Cadets to serve as commissioned officers and builds on and reinforces all the training and education from the previous three years.
- Military Science V (fifth-year Cadets) includes a Field Study for Cadets requiring a fifth year to graduate. Cadets in their fifth year will continue to train and lead other Cadets as they prepare to be commissioned officers in the United States Army.

Army ROTC offers the conventional four-year military science program where a student enters as a freshman. A three-year program for sophomores is also available. Additionally, a two-year program is offered for juniors and graduate students in some limited cases. Placement credit may be awarded to students with prior Air Force, Navy, or Marine Corps ROTC experience, students with prior or current military service, or to those students who volunteer for additional summer training at Fort Knox, Kentucky.

Scholarships covering full tuition and fees are available for entering freshman though a High School National Army ROTC Scholarship Board process. Applications for these scholarships are available online (https://www.goarmy.com/careers-and-jobs/find-your-path/army-officers/rotc/scholarships/). Otherwise, Cadets enrolled in Army ROTC can compete for campus-based scholarships through the department's Recruiting Operations Officer. All contracted Cadets (scholarship or non-scholarship) enrolled in the junior and senior years of ROTC are paid a tax-free monthly stipend of $420.00 for 10 months during the school year. Membership in the Virginia Tech Corps of Cadets is a pre-requisite for all ROTC classes. The cost of Cadet uniforms is paid by a special Army uniform allowance provided to each enrolled Cadet.

Minor in Leadership and Service

Satisfactory completion of the 26-credit military science curriculum will qualify each Cadet for a Minor in Leadership and Service awarded by the Virginia Tech College of Liberal Arts and Human Sciences.

Head: James B. Cogbill, Colonel, U.S. Army
Professor: J. B. Cogbill
Assistant Professors: D. Harrison, G. Calvert, J. Dufault, T. Spadine, and M. Jackson
Advisor: (540) 231-6401

Undergraduate Course Descriptions (MS)

MS 1005 - Military Science I, Army Reserve Officer Training Corps (2 credits)
First year of military science. MS 1005: Introduction to the Army introduces the personal challenges and competencies that are critical for effective leadership and communication. Student learning focuses on developing individual and interactive skills. Students learn how cultural understanding, goal setting, time management, stress management, and comprehensive fitness relates to leadership and the Army profession. Students further learn the ROTC course structure and progression, and are immersed into Army organizational culture via classroom instruction, physical fitness training, and leadership labs. MS 1006: Foundations of Agile and Adaptive Leadership introduces students to basic knowledge required to be a successful member of a military team, to include the U.S. Armys mission, its role and relationship in the American governance system, U.S. military customs and courtesies, operational terms and graphics, map reading, land navigation squad tactics, the Army Values and Warrior Ethos. This course includes reading assignments, homework assignments, practical exercises, a mid-term exam, and a final exam. Students receive systematic and specific feedback on leader attributes, values, and core leader competencies throughout the course. Successful completion of this course will help prepare cadets for Military Sci II, AROTC.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MS 1006 - Military Science I, Army Reserve Officer Training Corps (2 credits)
First year of military science. MS 1005: Introduction to the Army introduces the personal challenges and competencies that are critical for effective leadership and communication. Student learning focuses on developing individual and interactive skills. Students learn how cultural understanding, goal setting, time management, stress management, and comprehensive fitness relates to leadership and the Army profession. Students further learn the ROTC course structure and progression, and are immersed into Army organizational culture via classroom instruction, physical fitness training, and leadership labs. MS 1006: Foundations of Agile and Adaptive Leadership introduces students to basic knowledge required to be a successful member of a military team, to include the U.S. Armys mission, its role and relationship in the American governance system, U.S. military customs and courtesies, operational terms and graphics, map reading, land navigation squad tactics, the Army Values and Warrior Ethos. This course includes reading assignments, homework assignments, practical exercises, a mid-term exam, and a final exam. Students receive systematic and specific feedback on leader attributes, values, and core leader competencies throughout the course. Successful completion of this course will help prepare cadets for Military Sci II, AROTC.
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

MS 2005 - Military Science II, Army Reserve Officer Training Corps (3 credits)
Second year of military science. 2005: Troop Leading Procedures focuses on operations order production, leadership principles and styles, ethical and moral reasoning, land navigation and intermediate squad and platoon tactics. Required participation: leadership lab, physical training and field training exercises. 2006: Unified Land Operations focuses on doctrine and symbology, principles of joint operations, intermediate small unit tactics and leadership, effective communication, team building, counseling and coaching methods, code of conduct and law of land warfare. Required participation: leadership lab, physical training and field training exercises.
Prerequisite(s): MS 1005 and MS 1006
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MS 2006 - Military Science II, Army Reserve Officer Training Corps (3 credits)
Second year of military science. 2005: Troop Leading Procedures focuses on operations order production, leadership principles and styles, ethical and moral reasoning, land navigation and intermediate squad and platoon tactics. Required participation: leadership lab, physical training and field training exercises. 2006: Unified Land Operations focuses on doctrine and symbology, principles of joint operations, intermediate small unit tactics and leadership, effective communication, team building, counseling and coaching methods, code of conduct and law of land warfare. Required participation: leadership lab, physical training and field training exercises.
Prerequisite(s): MS 1006
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

MS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 3005 - Military Science III, Army Reserve Officer Training Corps (4 credits)
Third year of military science. 3005: Training management and the warfighting functions focuses on unified land operations, troop leading procedures, operations order production, written and oral communication, training management, squad leadership and tactics, squad and platoon offense/defense, land navigation, after action reviews, leadership, and physical training. Required participation: leadership lab, physical training and field training exercises. 3006: Applied leadership in small unit operations, squad and platoons offense/defense, basic rifle marksmanship, written and oral communication, land navigation, fires support to dismounted operations, leadership, physical training and preparation for advanced camp. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 2005 and MS 2006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 3006 - Military Science III, Army Reserve Officer Training Corps (4 credits)
Third year of military science. 3005: Training management and the warfighting functions focuses on unified land operations, troop leading procedures, operations order production, written and oral communication, training management, squad leadership and tactics, squad and platoon offense/defense, land navigation, after action reviews, leadership, and physical training. Required participation: leadership lab, physical training and field training exercises. 3006: Applied leadership in small unit operations, squad and platoons offense/defense, basic rifle marksmanship, written and oral communication, land navigation, fires support to dismounted operations, leadership, physical training and preparation for advanced camp. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 2005 and MS 2006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4005 - Military Science IV, Army Reserve Officer Training Corps (4 credits)
Fourth year of military science. 4005: The Army Officer focuses on development of the Army officer. It is an academically challenging course where students develop knowledge, skills, and abilities to plan, resource, and assess training at the small unit level. Students learn about Army programs that support counseling subordinates and evaluating performance, applying values and ethics to organizational problems, career planning, and legal responsibilities. Required participation: leadership lab, physical training and field training exercises. 4006: Company Grade Leadership focuses on preparing students to fulfill key leadership roles at the company level. This is an academically challenging course where students study, practice, develop, and apply critical thinking skills pertaining to Army leadership, officer skills, Army values and ethics, personal development, small unit tactics, platoon level leadership. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 3006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4006 - Military Science IV, Army Reserve Officer Training Corps (4 credits)
Fourth year of military science. 4005: The Army Officer focuses on development of the Army officer. It is an academically challenging course where students develop knowledge, skills, and abilities to plan, resource, and assess training at the small unit level. Students learn about Army programs that support counseling subordinates and evaluating performance, applying values and ethics to organizational problems, career planning, and legal responsibilities. Required participation: leadership lab, physical training and field training exercises. 4006: Company Grade Leadership focuses on preparing students to fulfill key leadership roles at the company level. This is an academically challenging course where students study, practice, develop, and apply critical thinking skills pertaining to Army leadership, officer skills, Army values and ethics, personal development, small unit tactics, platoon level leadership. Required participation: leadership lab, physical training and weekend field training exercises.
Prerequisite(s): MS 3005 and MS 3006
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

MS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

English

Our Website (http://www.english.vt.edu)

Overview

The Department of English offers majors in English (study in literature, including pre-Law and pre-Education options), Professional and Technical Writing, and Creative Writing. A degree in English will appeal to students who are interested in a foundational education in the liberal arts, specializing in literature and writing, and who may pursue careers in business, government, education, law, speech sciences, writing, publishing, advertising, health, activism, the arts, or social services.

The Department of English also offers minors in Literature, Language Sciences, Professional and Technical Writing, and Creative Writing, and many of its courses provide credits for Pathways general education in Discourse, Critical Thinking in the Humanities, Critique and Practice in Design and the Arts, and Critical Analysis of Equity and Identity in the U.S.

English Degree Majors

Students working towards the B.A. in English may choose from three majors, each consisting of 39 required hours.

- A major in English.
  Within the English major, there are three options available to students:
  - Literature,
  - Pre-Education, and
  - Pre-Law.
- A major in Professional and Technical Writing.
- A major in Creative Writing.

Degree Requirements

All three of the majors share a common English core that provides a foundational curriculum in research, critical thinking, and interpretation. Students in all three majors take these core courses together, providing a rich and diverse context for the study of writing and literature.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education requirements (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in English.

Satisfactory progress requirements toward the B.A. in English can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

Post Graduate Study

Undergraduate majors interested in pursuing advanced degrees (M.A., M.F.A., or Ph.D.) in English should, with the assistance of their professors, mentors, and the department's academic advisor, carefully plan their programs of study. Coverage across periods and genres is strongly recommended, as is a good reading knowledge of another language, for students planning to continue study for a master's or doctoral degree. Getting to know professors and learning as much as possible about the professional elements of the discipline provide excellent preparation for graduate work.

Pathways General Education and English

Pathways General Education requires a six hours of foundational Discourse credits and three hours of advanced or applied Discourse credits. ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing fulfill the six foundational credits of this Pathways requirement. These courses share a focus on the rhetorical dimensions of writing, speaking, and visual communication. Many 2000-4000 level ENGL courses fulfill the advanced or applied Discourse credits, and can count toward students' majors and Pathways general education. The same is true of most courses that fulfill Critical Thinking in the Humanities, Reasoning in the Social Sciences, Critique and Practice in Design and the Arts, and Critical Analysis of Identity and Equity in the U.S.; courses that meet one or more of these requirements can count for Pathways and major credit.

- Creative Writing Major (p. 986)
- English Major with Literature Option (p. 987)
- English Major with Pre-Education Option (p. 989)
- English Major with Pre-Law Option (p. 990)
- Technical and Scientific Communication Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/english/technical-scientific-communication-ba/)

Chair: Kelly Pender
Associate Chair: Gena Chandler
Assistant Chair: Jared Gibbs
Alumni Distinguished Professors: L. H. Roy
Clifford A Cutchins III Chair: Su Fang Ng
Professors: C. Eska, J. F. Eska, E. Falco, R. Hicok, K. Hodges, J. Ivory, B. McComisky, D. Mueller, S. F. Ng, K. Pender, K. M. Powell, D. H. Radcliffe, L. H. Roy, M. Vollmer, and R. Weaver-Hightower
Associate Professors: K. Carmichael, G. Chandler, K. Cleland, J. Dubinsky, S. M. Knapp, J. Mann, A. Reed, K. Queen, A. Wadoski, and A. J. Walker
Assistant Professors: S. Baniya, S. Cassnelli, C. Commer, S. Craig, J. Gerdes, C. Itchuaqiyaq, E. Lavender-Smith, C. Lindgren, S. Rabbi, G. Ramirez, T. Thompson, T. Webster, and A. Wiscomb
Collegiate Assistant Professor: S. Patel and M. Weaver
Visiting Assistant Professor: C. Farrington, S. Terazawa, and E. Waldman
Senior Instructors: R. Allnutt, M. Armstrong, E. Bloomer, R. Canter, S. GIlbert, A. F. Kinder, A. Lautenschlager, J. Lawrence, J. Mengert, J. Mooney, S. Mooney, A. Murphy, L. Neilan, S. Oakey, H. R. Patton, V. Ruccolo, and J. Scallorns
Advanced Instructors: N. Baker, S. Baker, C. Correll, J. A. Gibbs, A. Hobin, I. B. Johnson, S. Maycock, K. Morse, and J. Truscello
Instructors: N. Austin, T. Becker, S. Bennington, N. Brown, L. Corwin, C. Craig, N. Dragon, J. Drapeau, L. Fehr, T. Gardner, J. Greene, K. Hall, M. Hemmer, R. Hooper, A. Jones, L. S. King, S. Lohani, M. Marzolf, T. Passwater, S. Patcha-Lum, G. Saeidfar, T. Snyder, C. Taylor, B. Zaldivar Flores, M. Zaldivar, and J. Zan
Postdoctoral Fellows: S. Flego and K. E. Wright
Coordinator of Undergraduate Advising: Dawn Knight

Undergraduate Course Descriptions (ENGL)

ENGL 1EWL - Waiting List for English 1105 (0 credits)
Instructional Contact Hours: (0 Lec, 0 Crd)

ENGL 1004 - Books, Libraries, Archives (3 credits)
First-Year Experience course that introduces students to primary objects and methods of inquiry and invention in English studies. Introduction to library and archival research, ethical inquiry, social and historical function of reading, role of books in society, technologies of publication and reading, and writing effective summaries and critical reflections.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1105 - First-Year Writing (3 credits)
1105: Introduction to rhetorical analysis, visual rhetoric, critical writing, and critical thinking; intensive reading of works in multiple genres; practice in writing and revision; fundamentals of oral presentations. 1106: Continued study in rhetorical analysis and the conventions of various genres; intensive instruction in writing and revision of work that incorporates research; experience in oral presentations.
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1106 - First-Year Writing (3 credits)
1105: Introduction to rhetorical analysis, visual rhetoric, critical writing, and critical thinking; intensive reading of works in multiple genres; practice in writing and revision; fundamentals of oral presentations. 1106: Continued study in rhetorical analysis and the conventions of various genres; intensive instruction in writing and revision of work that incorporates research; experience in oral presentations.
Prerequisite(s): ENGL 1105
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1504 - Introduction to Contemporary Linguistics (3 credits)
Introduction to the sounds of language, processes by which words and sentences are formed, how the meanings of words are established by context, and why languages vary and change over time.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1514 - Language and Society (3 credits)
English language variation considered from social, regional, ethnic, gender, and style perspectives. Emphasis on vernacular varieties of American English. Attention paid to the social evolution of different language varieties and sociolinguistic perceptions of language ideologies. Introduction of methods of data analytics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1524 - Language and the Mind (3 credits)
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 1524

ENGL 1604 - Introduction to Poetry (3 credits)
Examination of poetry across historical periods, cultural contexts, and geographical areas. Emphasis on poetic forms and conventions, elements of poetic technique, poetic genres, and the vocabulary of poetic craft.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1614 - Introduction to Short Fiction (3 credits)
Analysis of short fiction and novellas from different historical periods and cultures. Emphasis on the structural elements of fiction, on its flexibility as a form for exploring human desires, conflicts, and values, and on its employment by writers from different cultures, ethnicities, and genders.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1624 - Introduction to Detective Fiction (3 credits)
Analysis of classic and modern texts of detective fiction selected from a variety of historical periods and cultural traditions. Emphasis on the structural elements of detective fiction, on its various sub-genres, and on its employment by writers from different cultures, ethnicities, and genders.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1634 - Introduction to Shakespeare (3 credits)
Introduction to Shakespeares drama and poetry, including at least one modern adaptation of a Shakespearean play (play, novel, movie, opera, etc.). Emphasis on the structural elements and conventions of the different genres of Shakespearean plays and poetry and on their representations of gender and ethnicity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1644 - Introduction to World Literature (3 credits)
World literature in translation. Texts from different time periods, nations, and cultures. Emphasis on close reading, literary elements and conventions, recurring themes, historical and cultural contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1654 - Introduction to Science Fiction and Fantasy (3 credits)
Introduction of literary works within the genres of science fiction and fantasy, focusing on the development and principal characteristics of each genre. Emphasis on the social, cultural, and historical contexts in which particular speculative texts have been produced.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1664 - Introduction to Womens Literature (3 credits)
Introduction to literature written by women, primarily in English. Focus on literary and cultural questions raised in womens writing throughout history and from different social and cultural backgrounds.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1704 - The Harry Potter Phenomenon (3 credits)
Introduction to a millennial childrens literature phenomenon, J.K. Rowlings seven-volume Harry Potter series, and to various critical and cultural responses to the books. Subgenres of fiction used in the series, such as the boarding-school novel and the sports novel; recurring themes in the series; critical concepts such as the Byronic hero and the anti-hero; the role of media in making the series an economic phenomenon; and the relationships of the novels to film versions and fan-fiction spin-offs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 1714 - True Crime Stories in American Culture (3 credits)
Analysis of true crime stories across various media and genres. Emphasis on the origins of true crime, narrative features and conventions of true crime stories, and the social, political, and ethical issues raised by their production and consumption, particularly in terms of race, gender, class, and other components of identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2014 - Food Writing (3 credits)
Introduction to the study, analysis, and production of food writing and food media; applied, iterative writing practices within multiple genres focused on the cultural and humanistic qualities of food.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2034 - Analyzing the Sounds of Language (3 credits)
Examination of the acoustic attributes of vowels and consonants using quantitative techniques. Statistical analysis of acoustical differences between and within speakers, enabling predictions about future language choices and outcomes. Basic introduction to using computational software for data processing and visualization, and to ethical issues that arise in collecting an analyzing data.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2044 - Contemporary African American Theatre (3 credits)
Contributions of U.S. Black theatre artists; intersectional identities; performances spaces and society; critical race theory; dramatic storytelling; cultural behaviors; racial discrimination.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2044, TA 2044

ENGL 2104 - African American Linguistics (3 credits)
Overview of some of the language varieties used by African Americans, including African American English, Black American Sign Language, Gullah, Louisiana Creole, and Afro-Latino varieties of Spanish and English. Focus on historical, contemporary, sociopolitical and linguistic factors impacting language practices at the individual and community level. Examination of African American language styles used in expressive forms of art and politics, but also how language ideologies shape responses to African American language in educational, political, and judicial settings. Uses lens of African American Language to explore key linguistic concepts like phonology, morphosyntax, prosody, language acquisition, language contact, and language change.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2104

ENGL 2434 - Legends of King Arthur (3 credits)
Introduction to legends of King Arthur, including stories, novels, and films from a wide historical timespan. Tales of knights, kings, and fair maidens that have entertained generations and irrevocably shaped cultural values surrounding gender relations, justice, violence, and the use and abuse of power. Analysis of individual texts and broader consideration of the Arthurian tradition during key literary-historical periods from the medieval era to the present.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2434

ENGL 2444 - Ancient Greek and Roman Mythology (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2444, RLCL 2444

ENGL 2534 - American Literary History (3 credits)
Introduction to American literary traditions, from the Colonial period through Modernism. Emphases on historical, social, and cultural contexts as these are reflected by representative texts.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2544 - British Literary History (3 credits)
Introduction to British literary traditions, from the Anglo-Saxon period through Modernism. Emphasis on historical, social, and cultural contexts as these are reflected by representative texts.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2604 - Introduction to Critical Reading (3 credits)
A writing intensive introduction to the techniques and theoretical implications of close reading and to the literary genres of poetry, drama, fiction, and, in some sections, non-fiction. The focus is on four primary texts, at least one of which was written before the eighteenth century and one after it, and on criticism of at least one of these. The course emphasizes the analytical skills, basic critical terminology, and conventions of literary criticism essential to advanced English studies. Intended primarily for English majors and minors.
Prerequisite(s): ENGL 1105 or COMM 1015
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2634 - Writing and Social Justice (3 credits)
Study of writings about social justice in various local and global contexts. Critical and rhetorical analysis of discourses in social justice through intersectional approaches.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2644 - Introduction to African-American Literature (3 credits)
An introduction to the principal themes, genres, and historical contexts of African-American literature. Formal elements of both the vernacular and written traditions. Impact of historical and social contexts. Ethical questions raised in the literature.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2644

ENGL 2664 - Being Human: Literature and Human Experience (3 credits)
Depictions of nature, the inhuman, and the superhuman in literature; literary explorations of empathy, technology, race, gender, language, dis/ability, and labor in human experience. Novels, short stories, and poems that explore issues of the human: how to define what is human (recognizing flexible and perhaps permeable boundaries between human and nonhuman), how to defend the human (humans at war with themselves and others), how humans are exploited (labor and human capital), and how humans change (technological development and future human evolution). Imaginative and ethical issues in different genres. Revolving topics course; may be repeated once for credit.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2724, LAHS 2724, STS 2724

ENGL 2744 - Introduction to Creative Writing (3 credits)
A workshop for beginning writers who will identify and apply formal elements of a variety of genres and employ the skills, tools, methods, and iterative processes used by creative writers to produce fully developed works of art.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2804 - Contemporary Native American Literatures (3 credits)
This course offers a sampling of fiction, poetry, and non-fiction by the most influential American Indian writers since 1970, authors such as Momaday, Silko, Deloria, Welch, Harjo, and Alexie. Students also learn about those aspects of cosmology and storytelling traditionally shared by all American Indian Nations, as well as about those aspects specific to the individual tribal traditions from which the authors and their characters come.
Prerequisite(s): ENGL 1106 or ENGL H1204 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2804

ENGL 2814 - Writing for Podcasts (3 credits)
Analysis of exemplary and diverse podcasts, in both audio and transcribed formats. Application of creative writing and technical skills necessary for the composition of original and diverse audio programs. Implementation of formal podcast elements, such as development, performance, structure, production, and promotion. Exploration of creative projects involving scriptwriting, serialized storytelling, hybridized genres, vocal performance, extemporization.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2844 - Introduction to Professional and Technical Writing (3 credits)
Foundations of professional and technical writing and its functions in workplace settings. Practice with problem solving and decision making, audience analysis, document design, usability, and inclusive and ethical documentation, individually and in teams. Practice writing workplace genres such as proposals, reports, and correspondence. Analyze how writing elements such as design, language choices, and diverse data sources affect a document's usability for different audiences.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 3024 - Religion and Literature (3 credits)
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of religion and literature. Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3024

ENGL 3134 - Gender and Linguistics (3 credits)
Exploration of differences--real and imagined--in the speech of men and women, and the relationship between these differences to culture. Exploration of how language can reflect and reinforce gender inequality. Linguistic phenomena covered: pitch, vocabulary, sound change, language ideologies, and discourse strategies and types.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 3134

ENGL 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3144, SOC 3144

ENGL 3154 - Literature, Medicine, and Culture (3 credits)
The representation of health and illness in literature and the cultural aspects of medicine as a practice.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3204 - Medieval Literature (3 credits)
This course presents medieval British literature from ca. 700 to 1500 in its representative modes and defining contexts, including the literary influences of pagan antiquity, the native British (Celtic) tradition, Scandinavian and contemporary continental influences, the Crusades, the Byzantine Empire, and the philosophical traditions of neoplatonism and scholasticism. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3214 - Renaissance Literature (3 credits)
This course presents Renaissance British literature from 1500-1660 in its representative modes and defining contexts, including the discovery of the Copernican universe and the new world, the rise of Protestantism, the resultant Counter-reformation, the movement from humanism to empiricism, and the institution of Parliamentary democracy. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3234 - Romantic Literature (3 credits)
This course presents Romantic literature from the late eighteenth century to 1832 in its representative modes and defining contexts, including the French, American, and Industrial Revolutions, the expansion of the British empire, the rise of the novel, Gothicism, and the intellectual influence of periodical essays. Specific authors and texts will vary, but will include poetry, fictional prose, and non-fictional prose.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3264 - Modernist British Literature (3 credits)
This course presents Modernist British literature from 1918-1945 in its representative modes and defining contexts, including World Wars I and II, the collapse of the British empire, the influence of Darwin, Marx, and Freud, and such literary movements as Modernism, Realism, and Stream of Consciousness. Specific authors and texts will vary, but will include poetry, prose, and drama.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3304 - The Languages of Native America (3 credits)
Study of the structures of the native languages of the Americas; their interrelationships; their use in individual speech communities; contact with other languages; the interrelationships of linguistic structure, culture, and thought; their future survival.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3304

ENGL 3315 - Playwriting (3 credits)
A workshop course in the craft and art of playwriting which emphasizes the development of craft and the nurturing of vision and art. 3315: primary focus is on the writing of original scripts with additional attention paid to the work of influential playwrights and critics. 3316: primary focus is on the creative process of developing a play with the collaborative influences of a director, actors, designers, and other theatre professionals. Consent of instructor required for 3316.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: TA 3315

ENGL 3324 - Acts of Interpretation (3 credits)
Foundational interpretive approaches in literary and rhetorical studies. Emphasis on broad frameworks and their implications for textual analysis.
Prerequisite(s): ENGL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3364 - Topics in Literature by Women (3 credits)
This rotating topics course examines literature written by women with different national and ethnic identities and from different historical periods. Specific content varies, but the common focus is on the fundamental issues surrounding womens writing, the critical methodologies commonly employed to analyze this writing, and the historical, social, and literary contexts influencing the particular writing being studied. May be repeated once with different content.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3424 - Topics in Russian Literature in English (3 credits)
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: RUS 3424

ENGL 3434 - The Works of Vladimir Nabokov (3 credits)
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RUS 3434

ENGL 3474 - Rhetoric for Professional Writers (3 credits)
Rhetorical theory and writing in professional, technical, and public contexts. Culture, access, power, and ethics in relation to rhetoric in professional and technical writing. Rhetoric strategies for textual and digital production.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3514 - Ethnic Literature for Children (3 credits)
This course examines the historical contexts of and issues surrounding ethnic literature for children. The course considers the literature in terms of aesthetics, cultural representations, and identity. Ethnic literatures considered may include Native American, African American, Asian American, and Latino/a. The course also introduces other ethnic literary traditions, such as world folk tales, that influence or parallel American ethnic childrens books.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3524 - Literature for Children (3 credits)
General critical and historical survey of traditional and contemporary writing for children: picture books, folk literature, modern fantasy, poetry, drama, modern fiction, historical fiction.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3534 - Literature and the Environment (3 credits)
Study of fiction, poetry, and non-fiction that examine environmental issues, sustainability, and the relationship between the human and natural worlds within a local and global context.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3544 - Literature and Cinema (3 credits)
Works of literature and the films into which they have been transformed; emphasis on differences between media.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CINE 3544

ENGL 3624 - Appalachian Literature (3 credits)
Appalachian literature from the region's beginnings to the present, including such diverse voices as women, Native American, Affrilachian, LGBTQ, and Latinx populations. Literary perspectives on the relationships between self, family, and community; place and displacement; and humans and the natural world. Analysis of stereotypes that have perpetuated inequity and displacement of power, as well as consideration of regional efforts to reclaim equity, power, place, and identity.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3624

ENGL 3644 - The Postcolonial Novel (3 credits)
A study of novels examining the historical, social, and cultural contexts before, during, and after colonization. Emphasis on major writers (e.g., Achebe, Coetzee, Roy, Phillips) across continents (Africa, Asia, North America) and the significant themes, tropes, and theories of the genre.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3654 - Ethnic American Literature (3 credits)
Variable content course which introduces major American ethnic literatures: African-American, Asian-American, Chicano/a, Arab-American, and Native American. Representative texts from one or two of these categories are examined within the cultural, historical, and geographical matrices within which they are written. May be repeated twice for credit if the content is different.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 3684 - Literature and the Law (3 credits)
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3684H - Literature and the Law (3 credits)
This course introduces students to the representation of the law and lawyers in literature. Emphasis is placed on the cultural and historical contexts that shape our perception of the law and legal practice and on the use of facts, research, interpretation, and rhetoric in legal argument. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3694 - Topics in World Novels (3 credits)
Rotating-topics course in world novels, either translated into, or originally written in, English. Emphasis on critical reading of novels written from different historic, intellectual, and cultural contexts. Formal and aesthetic analysis to identify themes, traditions, and values that cross periods and national boundaries. May be repeated once with different topics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 3704 - Creative Writing: Fiction (3 credits)
This course is designed for students who want to focus in some depth on the writing of various forms of fiction such as the short story and novella. Emphasis is on the writing the critiquing of original fiction in a workshop/studio environment, and the analysis of exemplary texts which serve as models. Students produce a body of original fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3714 - Creative Writing: Poetry (3 credits)
This course is designed for students who want to focus in some depth on the writing of poetry. Emphasis is on the writing and critiquing of original poetry in a workshop/studio environment, and the analysis of exemplary poems which serve as models. Students analyze various poetic forms and produce a revised body of original poetry. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3724 - Creative Writing: Creative Non-fiction (3 credits)
This course is designed for students who want to focus in some depth on the writing of creative non-fiction in its various forms, including memoir, personal experience writing, the lyrical essay, travel narratives, and nature writing. Emphasis is on the writing and critiquing of original creative non-fiction in a workshop/studio, environment and the analysis of exemplary texts which serve as models. Students produce a body of original non-fiction in draft and revised forms. May be repeated for a maximum of 9 credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 3734 - Community Writing (3 credits)
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative writing pedagogy and in creating sustainable community partnerships.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3734H - Community Writing (3 credits)
Introduction to the theory and practice of managing service- learning writing projects in schools, community centers, retirement communities, and public libraries. Survey of best practices in creative writing pedagogy and in creating sustainable community partnerships.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3744 - Writing Center Theory and Practice (3 credits)
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professors consent.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3744H - Writing Center Theory and Practice (3 credits)
Focus on the theory and practice of teaching writing across the disciplines in the Writing Center setting. Emphasis is on writing center theory applied to one-on-one teaching strategies and on techniques for responding appropriately to student writing. To take this course you must first have the professors contest.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3754 - Advanced Writing and Research (3 credits)
Advanced study in critical reading and writing for diverse academic, professional, civic, and/or personal contexts, culminating in a course portfolio; applied practice with audience-specific texts in multiple genres, modes, and styles; advanced instruction in research strategies and writing processes for complex rhetorical environments; emphasis on the influence of social and cultural identities across writing contexts.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3764 - Technical Writing (3 credits)
Principles and processes of effective written communication of technical information. Strategies for analyzing various workplace communication situations, adapting to audiences, evaluating online content, understanding ethical dimensions of research, and composing technical discourse, including organizing visual and verbal information. Practice in writing, individually and collaboratively, instructions and procedures, proposals and reports, correspondence, and presentations. Junior standing.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3774 - Business Writing (3 credits)
Principles and processes of effective communication required to succeed in business in global and intercultural contexts. Strategies for writing effective messages, analyzing workplace communication situations, adapting information to various audiences, conducting ethical research, giving oral presentations. Practice in writing memos, letters, emails, blog posts, proposals, and reports. Junior standing required.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3784 - Screenwriting (3 credits)
A workshop course in the craft and art of screenwriting, acquainting students with the standard format of screenplays and evaluation of dramatic structures of influential screenplays. Emphasis on construction of dramatic situations, employing the use of action in developing character and theme. Employment of scene as a visual unit of composition, and the evaluation of dramatic structures of influential screenplays.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3804 - Technical Editing and Style (3 credits)
Technical Editing and Style explores the art of editing from the initial writing task to the final delivery of the document. In addition to learning document management, students study and practice the roles, responsibilities, and tasks that editors perform. The course also covers the rules that govern the fundamentals of style (correctness, clarity, and propriety) and the principles needed to match the tone and formality to the aim, audience, and occasion of the work. Must have pre-requisites or the consent of the Director of Professional Writing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3814 - Creating User Documentation (3 credits)
This course prepares students to produce both print and online user documentation that enables people to accomplish a given set of tasks (e.g., user guides, online help, policy and procedure manuals, tutorials, and how-to books). Readings include rhetorical theory and discussions of professional practice. Students learn the principles of user and task analysis, information design, usability testing, and indexing. In addition, they have opportunities for hands-on experience with clients and end-users. Must have pre-requisites or the consent of the Director of Professional Writing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3824 - Visual Rhetoric and Document Design (3 credits)
Theory and practice of visual rhetoric and document design, including attention to ethical design standards and the sociocultural implications of design. Analysis of rhetorical situations to determine the needs of diverse audiences and make effective and ethical design choices. Application of rhetorical theories and formal design strategies to the production of print and digital artifacts using industry-standard design tools (i.e., Adobe InDesign, Illustrator, and Photoshop). Development of the ability to analyze and critique the work of others and to apply such assessments to improve designs in terms of aesthetics and usability.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3834 - Intercultural Issues in Professional Writing (3 credits)
Intercultural and global dimensions of professional and technical writing, including theoretical perspectives and practical applications. Theories of culture, context, identity, language, and technology as relevant to technical and professional communication. Issues of social equity and justice in the field of professional and technical writing. Approaches to engaging in intercultural communication in practice, including localization, globalization, translation, and designing information for and with communities.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3844 - Writing and Digital Media (3 credits)
Fundamental exercises in the production of digital media for internet-capable devices, such as data visualizations, videos, web design, and more. Introduction to ethical reasoning, and its application to contemporary issues about digital media and writing within the context of broader business, organizational, and political practices to collect and use user data.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

ENGL 3954 - Study Abroad (1-9 credits)
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)
Repeatability: up to 9 credit hours

ENGL 3954B - Study Abroad (1-6 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ENGL 3954M - Study Abroad (1-9 credits)
Pathway Concept Area(s): 6A Critique & Practice in Arts
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)

ENGL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4004 - Linguistic Discourse Analysis (3 credits)
Introduction to discourse analysis. This course examines spoken and written discourses of English. Further attention will be paid to how discourse functions in political, legal, medical, and educational contexts.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4054 - History of the English Language (3 credits)
Development of English including both its internal history (sounds, vocabulary, inflections, syntax) and its external history (political, social, and intellectual forces). Indo-European origins through the present, with special emphasis on the English Language in America.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4074 - Syntax (3 credits)
Examination of the systemic organization of sentence patterns in human languages. Formulation of problems and evaluation of competing syntatic analyses at the phrase and sentence levels. Analysis of the architecture of phases and of movement processes for grammatical and pragmatic informational coding.
Prerequisite(s): ENGL 1504
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4084 - Conducting Research in the Language Sciences (3 credits)
Research methodology for the study of linguistic structure, sociolinguistic variation, and cross-field approaches. Ethical research methods, data collection, data processing and analysis, presentation of research.
Prerequisite(s): ENGL 1504 and (ENGL 3134 or WGS 3134 or ENGL 3144 or RLCL 3144 or SOC 3144)
Corequisite(s): ENGL 4074, ENGL 4144
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4114 - Chaucer (3 credits)
Critical analysis of themes, styles, and structures in works of Geoffrey Chaucer. Ethical issues, historical context, and cultural traditions. Structure and vocabulary of Middle English. Influence in literary and critical traditions historically and today.
Prerequisite(s): (ENGL 1106 or ENGL 1204H) or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4124 - Introduction to Old English (3 credits)
Introduction to Old English grammar and reading of Old English poetry and prose. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4134 - Language Development (3 credits)
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono-and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSYC 4134

ENGL 4144 - Phonology (3 credits)
Examination of the systematic organization of sounds in human languages based upon problem-based learning. Analysis of syllables and morae, articulatory features, timing of articulatory gestures, and phonological processes that lead to sound change. Assessment of various theoretical and computational approaches to phonology including Articulatory Phonology, Prosodic Phonology, and Optimality Theory.
Prerequisite(s): ENGL 1504
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4164 - Studies in Shakespeare (3 credits)
Revolving topics in Shakespeares drama and poetry, with emphases on poetic and dramatic genres, historical and cultural contexts, significant themes, and popular reception. Additional attention paid to the critical discourse surrounding Shakespeares work. May be repeated twice with different content for a maximum of nine credit hours.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4204 - Hybrid Forms (3 credits)
Advanced writing workshop. Focus on the fusion of genres, such as prose poetry and multimedia writing, with special emphasis on anomalous and/or experimental forms, like cronicas/chronicles, manifesto/artist's statement, microfiction, erasure, collage, third person nonfiction, flash nonfiction, and the lyric essay. Skills, tools, methods, and iterative processes essential to the production of works of literary art.
Prerequisite(s): ENGL 3704 or ENGL 3714 or ENGL 3724
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4214 - Milton (3 credits)
Miltons poetry from the early works, including COMUS, LYCIDAS, and the sonnets, to his major late works PARADISE LOST, PARADISE REGAINED, and SAMSON AGONISTES; with some attention to the important prose and to the historical context in which he wrote.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4314 - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4314

ENGL 4314H - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 3154 or ENGL 3324
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4314

ENGL 4434 - The American Novel (3 credits)
Development of the American novel from its beginnings in the late 18th century to 20th century postmodernism. Emphasis on works representative of major authors (e.g., Twain and Morrison), important types (e.g., the romantic novel, the historical novel), and significant American themes (e.g., religion, nature, slavery, the frontier).
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4444 - The British Novel (3 credits)
Development of the British Novel from the mid- eighteenth century to World War II, including works by such novelists as Defoe and Austen (origins through romantic era), Dickens, Hardy, and Stevenson (Victorian and Edwardian era), Joyce, Woolf, and Waugh (modern period). Emphasis on evolution of generic styles and conventions against a changing landscape of historical and cultural change.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4474 - Special Topics in Professional and Technical Writing (3 credits)
Advanced, variable-content course that explores a significant or emergent professional & technical writing issue. Examines relevant theories and historical contexts to analyze relationships among rhetoric, culture, access, and power. Identifies common themes and approaches and applies these themes and approaches, shaped by current theories, to professional and technical writing projects. Individual sections focus on differing areas of professional and technical writing (to be specified in the subtitle of the course). May be repeated twice with different content for a maximum of nine credit hours. Pre: Junior Standing.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4504 - Modern Poetry (3 credits)
British and American poetry from 1900 to World War II with emphasis on such figures as Pound, Williams, Stevens, Yeats, Plath, Smith, and Eliot.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4514 - Contemporary Poetry (3 credits)
British and American poetry from World War II to the present, with emphasis on such figures as Bishop, Lowell, Ashbery, Heaney, and Hughes.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4624 - Studies in a British Author after 1800 (3 credits)
This course examines the life, work, and critical reception of a single major British author (or pair of closely associated authors) writing after 1800. May be taken up to 3 times with different content. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4634 - Studies in an American Author before 1900 (3 credits)
This course examines the life, work, and critical reception of a single major American author (or a pair of closely associated authors) writing before 1900. May be taken up to three times with different content. Junior standing is required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4644 - Studies in an American Author after 1900 (3 credits)
This course examines the life, work, and critical reception of a single major American author (or pair of closely associated authors) writing after 1900. May be taken up to three times with different content. Junior standing is required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

ENGL 4664 - Contemporary Fiction (3 credits)
Fiction since 1945 with emphasis upon the most recent two decades: the late modernist narratives of Bellow, Updike, and Percy; the new fiction of Barth, Hawkes, Barthelme; the postmodern fiction of Federman, Carter, Fowles, Katz, Sukenick.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4684 - Special Topics in Literature (3 credits)
An advanced, variable-content course which explores a significant or emergent literary issue or approach, or a body of literature. May be taken twice with different content.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4704 - Advanced Creative Writing: Fiction (3 credits)
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on skills students have acquired in creative writing workshops. Primary focus is on the writing and critiquing of original fiction, while paying close attention to the work of established writers who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own fiction.
Prerequisite(s): ENGL 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4714 - Advanced Creative Writing: Poetry (3 credits)
Designed for senior English majors who have selected the Creative Writing option, this is an intensive, advanced workshop. This capstone course builds on the skills acquired in previous creative writing workshops. Primary focus is on the writing and critiquing of original poems, while paying close attention to the work of established poets who are acknowledged masters of their genres. Students hone their skills as peer reviewers and constructive critics. In the process, they produce a portfolio of their own poetry.
Prerequisite(s): ENGL 3714
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4724 - Creative Writing: Fiction for Young People (3 credits)
This course is conducted in a workshop setting in which students compose original stories for young people. Elementary techniques of fiction are emphasized, such as plot structure, point of view, setting, characterization, and audience. Must have prerequisites or permission of the instructor.
Prerequisite(s): ENGL 3704
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4744 - Editing an Undergraduate Research Journal: Philologia (3 credits)
A seminar and professional development course on editing and producing a scholarly research journal. Emphasis on the day-to-day production operations of a research journal; the analysis, evaluation, and editing of manuscripts; journal design and layout; website content development; development and distribution of promotional materials; and the production of editorial exchange with authors.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4754 - Editing a Literary Journal (3 credits)
An experiential learning and professional development course on the history and day-to-day operations of literary journal editing with emphasis on composing blog posts and promotional materials, analyzation of the history of print culture, analyzation of current publications, the practice of copyediting and developmental editing, the evaluation of manuscripts for inclusion in a literary journal, the evaluation of job opportunities, and the composition of application materials.
Prerequisite(s): ENGL 1106 and ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4764 - Small Press Publishing (3 credits)
A seminar and professional development course on the history and day-to-day operations of small press culture and production. Emphasis on the design and distribution of promotional materials; the analysis, evaluation, and editing of manuscripts; and practice the art of editorial exchange with authors. Evaluation of job opportunities and composition of application materials. May be repeated 2 times with different content for a maximum of credit hours.
Prerequisite(s): ENGL 2744
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4784 - Senior Seminar (3 credits)
Designed for senior English majors, this is a variable topics, in-depth study of a particular issue or theme in language or literature. This capstone course aims to integrate and synthesize previous work in the discipline, focusing especially on close reading, research, and writing skills.
Prerequisite(s): ENGL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ENGL 4804 - Grant Proposals and Reports (3 credits)
This course prepares students to write effective proposals, reports, and informational articles. Students learn to define and write problem statements, program objectives, plans of action, evaluation plans, budget presentations, and summaries. In addition, they sharpen their teamwork, editing, writing, audience awareness, and design skills as they engage in collaborative projects with campus and/or non-profit organizations in the community. Prerequisite or consent of the instructor is required.
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4814 - Developing Online Content (3 credits)
Covers the process of creating documents for online environments. Builds on knowledge and skills acquired in foundational Professional Writing courses. Involves production of websites from scratch, starting with low-fidelity mockups and advancing to formatting layouts adaptable to the diverse screen sizes of computers and mobile devices. Focuses on a balance of structure (code), content (information), and format (presentation and design).
Prerequisite(s): ENGL 1106 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4824 - Science Writing (3 credits)
Writing in and about the natural and social sciences. Students will write documents such as abstracts, research proposals, and ethnographies, analyze the development of disciplinary writing practices, and study non-fiction science writing for general audiences. Senior standing or instructor approval required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4854 - Writing, Research, Study Abroad (3 credits)
Application of academic abroad experience to students disciplinary studies on campus. Conducted after international education abroad experience. Collaborative writing and research projects as well as individual, independent research. Approval of course instructor required. Open to all majors. Pre-requisite: A formal study abroad educational experience; department approval.
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4874 - Issues in Professional and Public Discourse (3 credits)
In this course designed for English majors in the Professional Writing Option, students will focus on the ways in which scientific, technical, and professional communication influence, and are influenced by, public discourse. Drawing on strategies of rhetorical criticism, students will gain an understanding of the persuasive value of style, arrangement, and delivery by investigating their professional roles in helping to structure public debate. Pre: Completion of at least 9 credit hours from the following courses: 2844, 3104, 3474, 3804, 3814, 3824, 3834, 3844, 4474, 4804, 4814, 4824.
Prerequisite(s): ENGL 3104 or ENGL 2844
Instructional Contact Hours: (3 Lec, 3 Crd)

ENGL 4954 - Study Abroad: Issues and Texts (1-6 credits)
An advanced, variable-content and multi-disciplinary course that explores global themes and literature(s) during a month-long, faculty-led summer study abroad experience. Pre-requisite: Junior Standing required. Variable credit course, repeatable up to 6 credits.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

ENGL 4954B - Study Abroad (1-6 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

ENGL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ENGL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Creative Writing Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
Foundational Theories and Content		
ENGL 1004	Books, Libraries, Archives	3
ENGL 1514	Language and Society	3
ENGL 2604	Introduction to Critical Reading	3
ENGL 3324	Acts of Interpretation	3
ENGL 3754	Advanced Writing and Research	3
English and Cross-cultural Representation		
Select two of the following:		6
ENGL 3144	Language and Ethnicity in the United States	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3834	Intercultural Issues in Professional Writing	
Subtotal		21
Major Requirements		
Fundamental Coursework		
ENGL 2744	Introduction to Creative Writing	3
ENGL 3704	Creative Writing: Fiction	3
ENGL 3714	Creative Writing: Poetry	3
Modern or Contemporary Literature		
Select one of the following:		3
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4664	Contemporary Fiction	
Creative Writing Elective		
Select one of the following:		3
ENGL 2814	Writing for Podcasts	
ENGL 3315	Playwriting	
ENGL 3724	Creative Writing: Creative Non-fiction	
ENGL 3734	Community Writing	
ENGL 4204	Hybrid Forms	
ENGL 4724	Creative Writing: Fiction for Young People	
Capstone Experience		
Select one of the following:		3
ENGL 4704	Advanced Creative Writing: Fiction	
ENGL 4714	Advanced Creative Writing: Poetry	
ENGL 3900	Bridge Experience	0
Subtotal		18
Free Electives		
Select 36 hours of Free Electives		36
Subtotal		36
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3

Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)	3
Pathways Concept 2 - Critical Thinking in the Humanities	
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)	6
Pathways Concept 3 - Reasoning in the Social Sciences	
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

[1] In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of ENGL 1106 First-Year Writing or COMM 1016 Communication Skills.

Satisfactory Progress toward the B.A. in English, Major in Creative Writing

Satisfactory progress toward the B.A. in English, Major in Creative Writing, requires that upon having attempted 72 credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal), students must have passed 12 of the required credits in the English Core (Section I) and have attained a GPA of 2.0 or better both within the major and overall.

Graduation Requirements

The B.A. in English with a Major in Creative Writing requires 39 hours in English, distributed as follows, and 120 hours overall. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement — i.e., completion of 1106 or COMM 1016. Some courses required for this major have other pre-requisites/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

In order to graduate, students must complete the degree with a GPA of 2.0 or better both within the Creative Writing Major and overall. All English courses above the 1000-level are factored into the in-major GPA.

Foreign Language Requirements

Foreign Language Requirement

- 3 years in high school *or*
- 2 years in high school + an 1106 foreign language (e.g., FR, GR, SPAN) *or*
- Less than 2 years in high school + an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping.
-

English Major with Literature Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Foundational Theories and Content		
ENGL 1004	Books, Libraries, Archives	3
ENGL 1514	Language and Society	3
ENGL 2604	Introduction to Critical Reading	3
ENGL 3324	Acts of Interpretation [1]	3
ENGL 3754	Advanced Writing and Research	3
English and Cross-cultural Representation		
Select two of the following:		6
ENGL 3144	Language and Ethnicity in the United States	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3834	Intercultural Issues in Professional Writing	
Subtotal		21
Major Requirements		
Literary History		
ENGL 2534	American Literary History	3
ENGL 2544	British Literary History	3
Capstone Experience		
ENGL 4784	Senior Seminar	3
ENGL 3900	Bridge Experience	0
Subtotal		9
Option Required Courses		
Literature Written Before 1800		
Select two of the following:		6
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 4114	Chaucer	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
ENGL 4684	Special Topics in Literature (appropriate section)	
ENGL 4784	Senior Seminar (appropriate section)	
English Elective		

Select one of the following:		3
ENGL 2534	American Literary History	
ENGL 2544	British Literary History	
ENGL/AFST 2644	Introduction to African-American Literature	
ENGL 2664	Being Human: Literature and Human Experience	
ENGL/AINS 2804	Contemporary Native American Literatures	
ENGL 3154	Literature, Medicine, and Culture	
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 3234	Romantic Literature	
ENGL 3244		
ENGL 3264	Modernist British Literature	
ENGL 3274		
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL 3534	Literature and the Environment	
ENGL/CINE 3544	Literature and Cinema	
ENGL 3624	Appalachian Literature	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3684	Literature and the Law	
ENGL 3684H	Literature and the Law	
ENGL 3694	Topics in World Novels	
ENGL 4054	History of the English Language	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
ENGL 4314	Narrative Medicine	
ENGL 4434	The American Novel	
ENGL 4444	The British Novel	
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4664	Contemporary Fiction	
ENGL 4684	Special Topics in Literature	
ENGL 4784	Senior Seminar	
Advanced Studies		
Select two of the following:		6
ENGL 3154	Literature, Medicine, and Culture	
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 3234	Romantic Literature	
ENGL 3244		
ENGL 3264	Modernist British Literature	
ENGL 3274		
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL 3534	Literature and the Environment	
ENGL 3544	Literature and Cinema	
ENGL 3624	Appalachian Literature	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3684	Literature and the Law	
ENGL 3694	Topics in World Novels	
ENGL 4054	History of the English Language	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
ENGL 4314	Narrative Medicine	
ENGL 4434	The American Novel	
ENGL 4444	The British Novel	
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4664	Contemporary Fiction	
ENGL 4684	Special Topics in Literature	
Capstone Experience		
ENGL 4784	Senior Seminar	
Subtotal		15
Free Electives		
Select 30 credits of Free Electives		30
Subtotal		30
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3

Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

[1] Course has other pre-requisites/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

Satisfactory Progress Toward the B.A. in English, Major in English: Literature Option

Satisfactory progress toward the B.A. in English, Major in English: Literature Option, requires that upon having attempted 72 credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal), students must have passed 12 of the required credits in the English Core (Section I) and have attained a GPA of 2.0 or better both within the major and overall.

In order to graduate, students must complete the degree with a GPA of 2.0 or better both within the English Major: Literature Option and overall. All English courses above the 1000-level are factored into the in-major GPA.

Graduation Requirements

The B.A. in English with a Major in English, in the Literature Option, requires 45 hours in English, distributed as follows, and 120 hours overall. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of 1106 or COMM 1016 Communication Skills. Some courses required for this major have other prerequisites/co-requisites and/or enrollment requirements. Such courses are identified by an asterisk (*) on this checksheet. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

In order to graduate, students must complete the degree with a GPA of 2.0 or better both within the English Major: Literature Option and overall. All English courses above the 1000-level are factored into the in-major GPA.

Foreign Language Requirement

- 3 years in high school *or*
- 2 years in high school + an 1106 foreign language (e.g., FR, GR, SPAN). *or*
- Less than 2 years in high school + an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping.
-

English Major with Pre-Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
Foundational Theories and Content		
ENGL 1004	Books, Libraries, Archives	3
ENGL 1514	Language and Society	3
ENGL 2604	Introduction to Critical Reading	3
ENGL 3324	Acts of Interpretation	3
ENGL 3754	Advanced Writing and Research	3
English and Cross-cultural Representation		
Select two of the following:		6
ENGL 3144	Language and Ethnicity in the United States	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3834	Intercultural Issues in Professional Writing	
Subtotal		21
Major Requirements		
Literary History		
ENGL 2534	American Literary History	3
ENGL 2544	British Literary History	3
Capstone Experience		
ENGL 4784	Senior Seminar	3
ENGL 3900	Bridge Experience	0
Option Required Courses		
Shakespeare		
ENGL 4164	Studies in Shakespeare	3
Literature by Women (3000 or 4000 level)		
Select one of the following:		3
ENGL 3364	Topics in Literature by Women	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4644	Studies in an American Author after 1900	
Underrepresented Authors		
Select one of the following:		3
ENGL 2644	Introduction to African-American Literature	
ENGL 3514	Ethnic Literature for Children	
ENGL 3654	Ethnic American Literature	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4644	Studies in an American Author after 1900	
Free Electives in English (3000 or 4000 level)		
Select six credits of Free Electives		6
Subtotal		24
Free Electives		
Select 30 hours of Free Electives		30
Subtotal		30
Pathways to General Education		
Pathways Concept 1 - Discourse		

ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g.Pathways).

[2] Course is required for this major have other pre-requisites/co-requisites and/or enrollment requirements. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of 1106 or COMM 1016 Communication Skills.

Satisfactory Progress Toward the B.A. in English, Major in English: Pre-Education Option

Satisfactory progress toward the B.A. in English, Major in English: Pre-Education Option, requires that upon having attempted 72 credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal), students must have passed 12 of the required credits in the English Core (Section I) and have attained a GPA of 2.0 or better both within the major and overall. In order to graduate, students must complete the degree with a GPA of 2.0 or better both within the English Major: Pre-Education Option and overall. All English courses above the 1000-level are factored into the in-major GPA.

Graduation Requirements

The B.A. in English with a Major in English, in the Pre-Education Option, requires 45 hours in English, distributed as follows, and 120 hours overall. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of 1106 or COMM 1016 Communication Skills . Some courses required for this major have other prerequisites/co-requisites and/or enrollment requirements. Such courses are identified by an asterisk (*) on this checksheet. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

Foreign Language Requirement

- 3 years in high school *or*
- 2 years in high school + an 1106 foreign language (e.g., FR, GR, SPAN) *or*
- Less than 2 years in high school + an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping.

English Major with Pre-Law Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
Foundational Theories and Content		
ENGL 1004	Books, Libraries, Archives	3
ENGL 1514	Language and Society	3
ENGL 2604	Introduction to Critical Reading	3
ENGL 3324	Acts of Interpretation	3
ENGL 3754	Advanced Writing and Research	3
English and Cross-cultural Representation		
Select two of the following:		6
ENGL 3144	Language and Ethnicity in the United States	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3834	Intercultural Issues in Professional Writing	
Subtotal		21
Major Requirements		
Literary History		
ENGL 2534	American Literary History	3
ENGL 2544	British Literary History	3
Capstone Experience		
ENGL 4784	Senior Seminar	3
ENGL 3900	Bridge Experience	0
Subtotal		9
Option Required Courses		
Prose Narrative		
Select one of the following:		3

ENGL 3644	The Postcolonial Novel	
ENGL 3694	Topics in World Novels	
ENGL 4434	The American Novel	
ENGL 4444	The British Novel	
ENGL 4664	Contemporary Fiction	
Underrepresented Authors		
Select one of the following:		3
ENGL 2644	Introduction to African-American Literature	
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL 3654	Ethnic American Literature	
Law and Literature		
ENGL 3684	Literature and the Law	3
Free Elective in English		
Select two of the following:		6
ENGL 3154	Literature, Medicine, and Culture	
ENGL 3204	Medieval Literature	
ENGL 3214	Renaissance Literature	
ENGL 3234	Romantic Literature	
ENGL 3244		
ENGL 3264	Modernist British Literature	
ENGL 3274		
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3524	Literature for Children	
ENGL 3534	Literature and the Environment	
ENGL 3544	Literature and Cinema	
ENGL 3624	Appalachian Literature	
ENGL 3644	The Postcolonial Novel	
ENGL 3684	Literature and the Law	
ENGL 3694	Topics in World Novels	
ENGL 4054	History of the English Language	
ENGL 4114	Chaucer	
ENGL 4124	Introduction to Old English	
ENGL 4164	Studies in Shakespeare	
ENGL 4214	Milton	
ENGL 4314	Narrative Medicine	
ENGL 4434	The American Novel	
ENGL 4444	The British Novel	
ENGL 4504	Modern Poetry	
ENGL 4514	Contemporary Poetry	
ENGL 4624	Studies in a British Author after 1800	
ENGL 4634	Studies in an American Author before 1900	
ENGL 4664	Contemporary Fiction	
ENGL 4684	Special Topics in Literature	
ENGL 4784	Senior Seminar	
Subtotal		15
Free Electives		
Select 30 hours of Free Electives		30
Subtotal		30
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of 1106 or COMM 1016 Communication Skills.

Satisfactory Progress Toward the B.A. in English, Major in English: Pre-Law Option

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In order to graduate, students must complete the degree with a GPA of 2.0 or better both within the English Major: Pre-Law Option and overall. All English courses above the 1000-level are factored into the in-major GPA.

Graduation Requirements

The B.A. in English with a Major in English, in the Pre-Law Option, requires 45 hours in English, distributed as follows, and 120 hours overall.

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways).

Note: All English courses above the 1000-level have as a pre-requisite completion of the First-Year Writing Requirement—i.e., completion of 1106 or COMM 1016 Communication Skills . Some courses required for this major have other prerequisites/co-requisites and/or enrollment requirements. Such courses are identified by an asterisk (*) on this checksheet. Please refer to the Undergraduate Catalog or consult your advisor for information about the specific pre-req/co-req or enrollment requirements for a specific course.

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- Less than 2 years in high school + an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping.
-

History

Our Website (http://www.liberalarts.vt.edu/departments-and-schools/department-of-history.html)

Overview

History is the study of people and events of the past to better understand how to meet the challenges of the future. Our students develop important 21st-century skills in research and analysis, speaking and writing excellence, the synthesis of diverse information, digital and media literacy, intercultural understanding, and historical/contextual expertise.

Widely recognized for promoting undergraduate research, the history curriculum prepares students for fulfilling careers in the technology sector, law, business, the military, intelligence, non-profit management and administration, healthcare, media and communication, information management, and education. History also provides the knowledge and skill students need for graduate work in Journalism, Law, Business, and Medicine, or the liberal arts or social sciences.

Courses at the 1000 level are introductory surveys open to anyone with an interest in history but without a strong background in the subject. Students intending to continue in history should take these courses in their freshman or sophomore years. Courses at the 2000 level, with the exception of Historical Methods, are introductory surveys of particular topics for a general undergraduate audience. Courses at the 3000 level, primarily for sophomores and above, provide more focused and detailed study of a period, place, or topic introduced at the 1000 or 2000 level. Courses at the 4000 level are conducted as seminars that emphasize original writing and research, and are generally restricted to students with junior standing or above who have already taken six hours or more of college-level history.

Majors

The history curriculum is designed to introduce fundamental skills of the discipline, followed by upper division courses that develop knowledge and skills, culminating in a capstone research experience. It is a deliberately flexible curriculum built to encourage students to double major, minor, or undertake study abroad, internships, and/or undergraduate research.

History majors complete a minimum of 39 hours in History, including 21 hours of core history courses and 18 hours of depth studies that can be tailored to students' own interests.

Majors who choose to undertake the Research/Thesis Option will complete the requirements of the B.A. in History and six hours of undergraduate research that results in the completion of a Thesis, OR three hours of undergraduate research that builds on work completed in HIST 4914 History Research Seminar along with three hours of History elective credit at the 2000 level or above.

Minors

History minors require completion of a minimum of 18 hours of history courses, some of which must meet a Depth Studies requirement. We offer minors in History, War and Society, American Indian Studies, Asian Studies, and Russian Area Studies. You may find requirements by visiting the University Registrar website http://registrar.vt.edu/graduation-multi-brief/index1.html.

Advising

A professional advisor assists each major in planning to meet their degree requirements. The student is expected to confer with the advisor at regular intervals regarding the progress of his or her studies. Students also work with one or more faculty mentors who provide guidance regarding academic and professional choices.

Virginia Tech offers extensive career advising (http://career.vt.edu/).

Experiential Learning

The history department encourages our students to undertake study abroad, internships, and undergraduate research projects and offers students curriculum that allows them to achieve academic credit for these experiences. Check out the wide variety of study abroad programs available through the Global Education Office (https://www.globaleducation.vt.edu/). Research the wide array of career-related experiences (http://career.vt.edu/experience.html) you can have while still in College, especially Hokies4Hire (http://career.vt.edu/job-search/H4H-OCI.html).

Honors

Outstanding history majors may be eligible to join the Honors College and complete an Honors Laureate Diploma. For more about the Honors College, please visit https://honorscollege.vt.edu.

Student Organization

The department is host to a student-run History Club and a local chapter of the National History Honors Society Phi Alpha Theta. Social and academic events allow for informal interaction between students and faculty. Don't miss our annual trivia competition Stump the Chumps between faculty, undergraduates, and graduate students!

Satisfactory Progress

Satisfactory progress requirements toward the B.A. in history can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- History Major (p. 1002)
- History Major with Undergraduate Research/Thesis Option (p. 1004)

Chair: Jennifer Hart
Associate Chair: Carmen Gitre
Professors: M.V. Barrow Jr., L. A. Belmonte, A.R. Ekirch, E.T. Ewing, M. Heaton, R.F. Hirsh, B. L. Shadle, and P.R. Wallenstein
Associate Professors: D. Agmon, G.R. Bugh , S. Cook, N. Copeland, A. Demmer, C. Gitre, E. Gitre, H. L. Gumbert, D.P. Halpin, M. Kiechle, M. Mollin , P. Quigley, H. Schneider, R. P. Stephens, J. Taylor, D.B. Thorp, L. Winling, A. Zeide
Assistant Professors: R. Midura, E. Polanco
Collegiate Associate Professor: M. Dufour
Collegiate Assistant Professor: D. Freas
Instructor: A. Narayanan

Undergraduate Course Descriptions (HIST)

HIST 1004 - Introduction to History (3 credits)
Introduces students to the main concepts and issues of discipline of history. Familiarizes students with the Department of History, educational requirements, university resources, and career opportunities for History majors.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1014 - Topics in Reacting to the Past (3 credits)
Introduction to fundamental issues in history through historical simulations. Enacting specific roles in historical situations while improving liberal learning skills, including evaluating evidence, understanding multiple perspectives, writing persuasive essays, and developing public speaking skills. Specific topics may vary from semester to semester. May be repeated one time with different content for a maximum of six credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 1024 - Ancient History (3 credits)
Surveys the civilizations and peoples of Greece, Rome, and the Ancient Near East (including Egypt and Mesopotamia) from the invention of writing around 3,000 B.C. to the fall of the Roman Empire in the fifth century C.E. through study of literature as well as archaeological artifacts. Examines the interactions and interdependencies of these civilizations and considers their enduring influence.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1025 - Introduction to European History (3 credits)
Examines the political, social, and cultural history of Europe since the medieval period. Focuses on the complex interplay between demographic transformation, social and political change, and cultural development. 1025: Explores the legacy of the Roman Empire, the expansion and consolidation of "Europe," the medieval world and expansion in the Atlantic World. 1026: Explores the rise of Absolutism and the Enlightenment, the Age of Revolutions, imperialism, the rise of new political ideologies and nation-building, and Europe in the twentieth century world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1026 - Introduction to European History (3 credits)
Examines the political, social, and cultural history of Europe since the medieval period. Focuses on the complex interplay between demographic transformation, social and political change, and cultural development. 1025: Explores the legacy of the Roman Empire, the expansion and consolidation of "Europe," the medieval world and expansion in the Atlantic World. 1026: Explores the rise of Absolutism and the Enlightenment, the Age of Revolutions, imperialism, the rise of new political ideologies and nation-building, and Europe in the twentieth century world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1084, RLCL 1084, SOC 1084

HIST 1115 - History of the United States (3 credits)
Examines the history of the United States through intersections of politics, economics, sciences, the arts and significant social movements. Considers how the modern United States has emerged through the interactions of diverse ethnic, racial, national, class, and religious groups. 1115: pre-Columbian societies through the Civil War; 1116: Reconstruction through present. Sequence recommended as preparation for advanced courses in United States history.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1116 - History of the United States (3 credits)
Examines the history of the United States through intersections of politics, economics, sciences, the arts and significant social movements. Considers how the modern United States has emerged through the interactions of diverse ethnic, racial, national, class, and religious groups. 1115: pre-Columbian societies through the Civil War; 1116: Reconstruction through present. Sequence recommended as preparation for advanced courses in United States history.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1214 - History of the Modern World (3 credits)
An examination of the global significance of the critical political, social, cultural, and international issues in the 20th century.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1215 - Intro to World History (3 credits)
Examine political, economic, social, and cultural change around the world over the course of human existence, with particular emphasis connections and comparisons of human societies across space and time. 1215: Covers early civilizations to 1500 CE. Major themes include the development of human civilization and the interactions of different societies through exchange of people, ideas, goods, and disease. 1216: Covers from 1500 CE to present. Major themes include the spread of European imperialism and resistance to it, development of nation-states, world wars, and post-colonial globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1216 - Intro to World History (3 credits)
Examine political, economic, social, and cultural change around the world over the course of human existence, with particular emphasis connections and comparisons of human societies across space and time. 1215: Covers early civilizations to 1500 CE. Major themes include the development of human civilization and the interactions of different societies through exchange of people, ideas, goods, and disease. 1216: Covers from 1500 CE to present. Major themes include the spread of European imperialism and resistance to it, development of nation-states, world wars, and post-colonial globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1224 - Conquest and Culture in Latin American Empires (3 credits)
Explores major themes and events in the political and cultural history of major empires in Mexico and Peru from 900 to 1600. Examines the emergence of indigenous empires, their confrontation with European conquistadors, and life in the early colonial period. Discusses the cultural collision that occurred when Europeans arrived in the Americas, and complicates the narrative of the conquest. Focuses on the complex interplay between geography, political and economic organization, and social change. Investigates the position of indigenous peoples in pre-Columbian and European empires in Mesoamerica and the Andes. Discussion of the methods and sources to interpret postclassic and early Colonial Latin America.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1354 - Conflict and Security in Modern East Asia (3 credits)
Survey of the 20th century history of five states in northeast Asia, People's Republic of China, Taiwan, Japan, North and South Korea, and the connections between them. Causes and consequences of war, colonization and nationalist movements and their implications for contemporary regional and global relations. Emphasis on cultural concepts, political ideologies, social relations and historical conflicts as background to current security concerns.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1515 - History of Africa (3 credits)
Examines political, economic, social and cultural themes in African history from the beginnings of human civilization to the recent past, with particular emphasis on historical experiences of race, gender, class, religion, ethnicity, and nationality. 1515: Covers early civilizations through the abolition of the slave trade. Examines migrations and trade, the expansion of Islam, and slavery in Africa and the Atlantic and Indian Oceans. 1516: Covers Africa since the nineteenth century. Examines European conquest, and major political, cultural and social changes during the colonial and post-colonial eras.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1516 - History of Africa (3 credits)
Examines political, economic, social and cultural themes in African history from the beginnings of human civilization to the recent past, with particular emphasis on historical experiences of race, gender, class, religion, ethnicity and nationality. 1515: Covers early civilizations thorugh the abolitionof the slave trade. Examines migrations and trade, the expansion of Islam, and slavery in African and the Atlantic and Indian Oceans. 1516: Covers Africa since the nineteenth century. Examines European conquest, and major political, cultural and social changes during the colonial and post-colonial eras.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1764 - History of Rock n Roll (3 credits)
Rock 'n' roll in historic and cultural contexts. Effects on social identity, worldviews, economic justice, cultural appropriation, diversity, power, and traditions. Creative and aesthetic influences in human experience and cultural expression. Significant music figures, movements, and trends in artistic, political, social, technological, and industrial developments in the U.S.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2004 - Historical Methods (3 credits)
Explanation of the discipline of history: its history, philosophies, and methods, with emphasis on historical research.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2054 - Engineering Cultures (3 credits)
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2054

HIST 2104 - Topics and Critical Issues in US History (3 credits)
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in the history of the United States. Emphasis on the study of source materials and historical interpretations of specific themes in American history. Themes grounded in issues of class, race, gender, and equality in US history. Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2114 - Topics and Critical Issues in European History (3 credits)
Introduction to the problems, methods and skills of the discipline of history through the study of significant themes and critical issues in European history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Themes grounded in European history/Europe's role in world that interrogate the concept of "the West." Specific topics will vary from semester to semester. Course may be repeated twice for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2124 - Topics and Critical Issues in World History (3 credits)
Introduction to the problems, methods and fundamental skills of the discipline of history through the study of significant themes and critical issues in world history. Emphasis on the study of source materials and historical interpretations. Specific thematic content is variable. Examines political, economic, social, and cultural change at historically specific periods of time around the world with a focus on drawing comparisons and making connections across regional spaces. Specific topics may vary from semester to semester. May be repeated two times with different content for a maximum of 9 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 2134 - The Revolution Will Be Televised: Topics in History on TV (3 credits)
Explores topics in history through the lens of specific TV shows or series. Featured shows and topics will vary from semester to semester. Considers how television programs have represented historical events, ideas, and communicated ideas about race, gender, sexuality, class, or culture. May be repeated once with different content for a maximum of 6 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 2166 - History of France (3 credits)
French history from Roman Gaul to the present. 2165: Roman, Medieval, and Renaissance France; Absolute Monarchy. 2166: The Revolution; Nineteenth and Twentieth Century France.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2184 - History of the Balkans (3 credits)
History of Southeastern Europe from the sixth century to the present. Chief themes are movement of peoples, Byzantine and Ottoman Empires, religious conflicts, social developments, and rival nationalisms.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2224 - Ancient Greek and Roman Women (3 credits)
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2224

HIST 2234 - Classics in the Modern World (3 credits)
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2234

HIST 2244 - Cities of Rome (3 credits)
Examines the building development of the ancient city of Rome and selected Roman cities; investigates how social, political, and cultural aspects of private and public architecture in these physical cities both create meaning and preserve memory. Explores the ways in which later cultures, especially through literature, have engaged with the pervasive and persistent influence of ancient Rome, not just as a physical place, but also as a cultural construct.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2244

HIST 2264 - America in the 1960s (3 credits)
Surveys the political, social, and cultural history of the U.S. over the long Sixties (mid-1950s to mid-1970s). Examines the civil rights movement, Vietnam War and antiwar movement, identity politics, cultural revolutions, American liberalism, and American conservatism. Explores how intersection of race, class, gender, ethnicity and age shaped varying experiences of the 1960s. Emphasis on the study of source materials and historical interpretations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2275 - African-American History (3 credits)
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2275

HIST 2276 - African-American History (3 credits)
2275: African continent through Civil War. Examines trajectory of slavery as well as its global impacts and legacy, the development of racial thought, slave resistance and rebellions, the fight for Emancipation, and African American contributions to culture, economics and society of United States. 2276: Reconstruction through present. Examines impact and legacy of Reconstruction, the fight against Jim Crow segregation, and the social, cultural, political and economic contributions of African Americans in the nineteenth and twentieth century United States. Exploration of the global implications of race relations in the United States.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2276

HIST 2345 - History of the Middle East (3 credits)
History of the Middle East from the seventh century to today, with emphasis on formation of Islamic civilization, medieval and early modern political systems, European imperialism, and the struggle for independence. 2345: seventh century to 1914; 2346: independence, wars, revolutions, and social change since 1914.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2346 - History of the Middle East (3 credits)
History of the Middle East from the seventh century to today, with emphasis on formation of Islamic civilization, medieval and early modern political systems, European imperialism, and the struggle for independence. 2345: seventh century to 1914; 2346: independence, wars, revolutions, and social change since 1914.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2355 - History of China (3 credits)
China from prehistory to the present. Special attention to political, social, economic, and cultural developments. 2355: Prehistory, Imperial China to the sixteenth century; 2356: late Imperial China to modern and contemporary China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2356 - History of China (3 credits)
China from prehistory to the present. Special attention to political, social, economic, and cultural developments. 2355: Prehistory, Imperial China to the sixteenth century; 2356: late Imperial China to modern and contemporary China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2364 - History of Japan (3 credits)
Political, social, economic, and cultural development of Japan from earliest times to present; emphasis on problems of modernization in the nineteenth and the twentieth centuries.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2374 - Gods and Kings in Premodern India (3 credits)
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2374

HIST 2384 - Gandhi in the Making of Modern India (3 credits)
History of India since approximately 1700, with particular focus on Gandhis influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhis role in political, social, cultural, and religious movements of the early 20th century, and Gandhis legacy in the independent states of South Asia and the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2384

HIST 2394 - Tofu to Tikka: Food in Asian History (3 credits)
Exploration of the evolution and alterations of food and cuisines throughout Asian history. Examination of the economic, geographical, political, philosophical/religious, and social underpinnings of food in premodern Asian societies; influence of the Columbian Exchange of Asian and global cuisines; Euro-American imperialism's impact on food and society in Asia and in the European and American metropoles; emergence of national cuisines in Asia; and Asian food in the post-colonial diaspora.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2394

HIST 2484 - Modern Germany (3 credits)
Political, social, economic, and cultural history of Germany since 1815. Discussion of the origins, experience and impact of political ideologies and national unification/reunification, colonial expansion, Nazism, war and genocide, and the role of Germany in Europe and the world. Diverse perspectives on German history and its implications through primary and secondary source materials. Particular focus on historiographical interpretations of the German past.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2494 - Cities in History (3 credits)
Examines the changing conditions of urban life and the shifting roles that cities have played in U.S. history. Identifies transformations and movements in physical development, including urban form, architecture, urban planning, infrastructure, and environmental conditions. Details the processes of immigration and the consequences of demographic change in cities. Analyzes the contests over politics arising from these urban changes.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2504 - Crime and Punishment in American History (3 credits)
Analyzes changing understandings of crime and punishment from the Colonial Era to the Age of Mass Incarceration. Considers how factors of race, ethnicity, class, and gender intersected with changing ideas of criminality and punishments.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 2504

HIST 2514 - U.S. Food History (3 credits)
Introduction to the history of food in the United States. Examines food cultures, food systems, food industries, nutrition, government regulation, inequalities, and environmental effects of food and agricultural production. Studies these topics across different demographics in the United States and its global context, with attention to change over time.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2524 - History of Agriculture (3 credits)
Survey of agricultural history in the United States, with comparative global case studies. Examination of indigenous practices, labor, development of market economies, relationships among plants and animals, scientific and technological change, landscape transformation and sustainability, food systems, and inequality and exploitation within cultures and societies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2534 - America at War (3 credits)
The United States at war from the American Revolution to the War on Terror. Emphasis on how U.S. policymakers have justified war, popular understandings of "the enemy," the merits and limitations of distinctions between civilians and service members, and the role of technological innovation. Engagements with interdisciplinary and intersectional perspectives with a war and society approach.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2544 - U.S. South: Pre-Colombian to 1865 (3 credits)
Surveys history and cultures of the U.S. South from the Pre-Colombian era to the modern South. Analyzes the enslavement and emancipation of Black southerners, slave resistance, the impact of capitalism, Reconstruction, the creation of the Lost Cause mythology and Jim Crow segregation. Examines the political and economic influences of the region from the emergence of abolitionist thought, populism, the long struggle for racial equality, and the creation of the Sunbelt. Special emphasis placed on struggles for social justice, civil rights and demographic changes within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2554 - U.S. South: 1865 to Present (3 credits)
Surveys history and cultures of the U.S. South from the Pre-Colombian era to the modern South. Analyzes the enslavement and emancipation of Black southerners, slave resistance, the impact of capitalism, Reconstruction, the creation of the Lost Cause mythology and Jim Crow segregation. Examines the political and economic influences of the region from the emergence of abolitionist thought, populism, the long struggle for racial equality, and the creation of the Sunbelt. Special emphasis placed on struggles for social justice, civil rights and demographic changes within the region.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2604, STS 2604

HIST 2624 - Topics in the History of Data in Social Context (3 credits)
Examination of the meaning of data in historical context. Exploration of how historical context shapes classification, collection, and interpretation of data. Analysis of data as a meaningful category of human experience. Variable content. May be repeated once for up to six (6) hours of credit.
Pathway Concept Area(s): 1A Discourse Advanced, 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 2715 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2715

HIST 2716 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2716

HIST 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2724, LAHS 2724, STS 2724

HIST 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 2984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 3004 - Colonial America (3 credits)
Critical analysis of early American society. Founding and development of the colonies in the 17th century; 18th century colonial life.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3014 - The American Revolution (3 credits)
Causes, nature, and results of the American Revolution, 1763- 1789.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3054 - The American Civil War (3 credits)
Causes, course, and consequences of the American Civil War. Emphasis on transformations in regional and national identity, race relations, the status of African Americans, gender roles, military affairs, and the United States place on the world stage. Develop skill in written and oral discourse.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3084 - Recent America, 1917-Present (3 credits)
Social, economic, cultural, and political history of America from the entry into World War I, the turbulent 1920s, the Great Depression, the New Deal, World War II, postwar prosperity, the Cold War, social and cultural ferment, Vietnam, Watergate, to the new anxieties about the limits of power in the 1980s.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3105 - Women in U S History (3 credits)
Roles of women from colonial settlement to the present. Special attention to family experiences, political agendas, and economic contributions of women and to social construction of gender identities. 3105: to 1865; 3106: since 1865.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3106 - Women in U S History (3 credits)
Roles of women from colonial settlement to the present. Special attention to family experiences, political agendas, and economic contributions of women and to social construction of gender identities. 3105: to 1865; 3106: since 1865.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3124 - Murder in American History (3 credits)
Considers how the definition of murder as a crime has changed from the colonial period to the present day. Uses murder cases to study the dynamics of American society in condemning, condoning, or celebrating murder. Asks how cultural factors, including racial prejudice, gender stereotypes, beliefs about sexuality, and class status affected the act of killing, media coverage of the event, societal reactions, and the execution of justice. Topics covered include abortion, lynching, vigilante justice, and the evolution of the legal system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 3124

HIST 3134 - Sports in American History (3 credits)
Impact of sports in American history. Emphasis on the impact of team sports (college and professional basketball, baseball, and football) and individual sports (golf, boxing, and automobile racing) on the development of American society and culture.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3144 - American Environmental History (3 credits)
Explores interactions between Americans and the environment from the time of European contact to the recent past. Traces the sometimes unexpected ways in which nature has shaped history, humans have altered the natural world, environmental attitudes have evolved, and environmental inequalities have arisen.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3164 - Sexuality in American History (3 credits)
Examines the changing social and cultural meanigns of sexual behavior and identity in American life from the colonial era to the present. Explores relationships between sexuality and power, culture and politics, and government regulation with consideration of theoretical frameworks of interpretation. Focuses on dynamics of race, ethnicity, gender, and class.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3174 - Native American History (3 credits)
The Native experience in North America or Latin America from 1491 to present. Emphasis on social diversity and organization, resistance to colonization, leadership and cultural change, and political sovereignty among indigenous peoples. Methods for interpreting a variety of primary sources, including texts, material culture, and archaeological findings. Engagements with shifting historiographical perspectives and political movements for recognition of Native sovereignty.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3174

HIST 3184 - Food Sovereignty (3 credits)
Food sovereignty, the right to produce and consume culturally relevant food, as a set of practices and as a social movement through comparative case studies. Origins of food sovereignty in response to effects of colonialism, the green revolution, and the global corporate food system on peasant and Indigenous subsistence livelihoods and the concept's transformation through dialogue with indigenous agricultural knowledge and poor peoples' environmentalism. Food sovereignty's challenge to the dominant food system and conceptions of development, how groups implement this vision of democratized social and productive relations through projects of agroecology and land reform, and its potential in the context of ecological calamity.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3184

HIST 3214 - History of Appalachia (3 credits)
Early settlement, religion, the pre-industrial economy, the coming of the coal and lumber industries, labor activism, politics, migration, and regional identity.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3214

HIST 3224 - History of Virginia (3 credits)
Social, political, cultural, and economic developments in Virginia, from the sixteenth century to the present.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3234 - The North American West (3 credits)
A study of the peoples and history of the North American West from the sixteenth century through the twentieth.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3254 - The Vietnam War (3 credits)
A critical study of the causes and consequences of the Vietnam War, 1945-1975. Analysis of Americas strategic and military objectives, the nature and conduct of the war, and the growth of the antiwar movement at home.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3274 - The Greek City (3 credits)
History of the ancient Greek city-state (polis) from the Archaic period (800-500 BC) to the creation of the Roman Empire. Principal topics are: origins and definition of the polis; Greek colonization throughout the Mediterranean and Black Seas; the struggle for autonomy in the Classical and Hellenistic periods; and the Hellenizing impact of the polis on non-Greek populations.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3284 - The Roman Revolution (3 credits)
History of the Roman world from 264 B.C. to A.D. 180. Particular attention to the three themes of imperialism, revolution, and empire through extensive reading of the contemporary authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3294 - Roman Britain (3 credits)
Examines the social, political, and military origins of early England from Stonehenge to the Norman Conquest; emphasis on archaeology and material culture; and the legacy of the Romans and Romanization on forging a British identity.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3304 - The World of Alexander the Great (3 credits)
Examines the life and times of Alexander the Great and the Hellenistic World, a new cosmopolitan multicultural world initiated by his conquests. Analyzes the rise of Mecedon, the accomplishments and powers of Alexander, and discusses the world forged after him through analysis of literary and non-literary primary sources.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3314 - The Later Roman Empire (3 credits)
Roman Empire in the west from A.D. 180 to A.D. 476 and in the east from A.D. 476 to A.D. 1071. Particular attention to the causes of the fall of the empire in the west and to the Byzantine Empire in the east until the coming of the Turks and the Christian Crusaders.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3324 - The Medieval World (3 credits)
Characteristic thought and institutions of high and late Middle Ages.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3334 - The Renaissance (3 credits)
The Italian Renaissance in its European context. Emphasis upon the culture and institutions of Italian states from 1300 to 1500.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3344 - The Era of The Reformation (3 credits)
Development of Protestantism and reformation of the Catholic Church from 1500 to about 1600. Emphasis upon social, political, and economic factors as well as theology. Examination of conflicts engendered by the reformation movements.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3354 - Reform and Revolution in Early Modern England (3 credits)
Examines the political, social, economic, and religious history of early modern England. Focus on the English Reformation and descent into Civil War and Revolution. Discussion of the Houses of Tudor and Stuart and their roles in radically transforming England into a constitutional monarchy in which the rule of law reigned supreme. Engagement with diverse perspectives on the religious, social, and political upheaval of the sixteenth and seventeenth centuries through focused study of primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3364 - The Age of Revolution and Napoleon (3 credits)
The French Revolution in its European and global context, with particular attention to social and political causes of unrest, strategies of popular mobilization, debates about authority and order, the emergence of empires, and the long-term implications of revolutionary change.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3374 - French Empire (3 credits)
History of French empire from the seventeenth century to the present, in the Carribean, Canada, Asia, North America and Sub-Saharan Africa. Considers indepdendence movements and the effects of post-colonial migrations on metropolitan France. Focus on issues of religion, race, and human rights
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3484 - Nazi Germany: History and Memory (3 credits)
Causes, course, and consequences of the rise of National Socialism in Germany. Political, economic, social, and cultural aspects of life in Germany. Conditions of Weimar Germany; fascism; the emergence of the Nazi Party and its acquisition, exercise and abuse of power; transformation of German society; the problem of Hitler; the Second World War and Holocaust; and memory and representation of the Nazi period.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, and personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3494, RLCL 3494

HIST 3504 - The Age of The Crusades (3 credits)
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3504

HIST 3534 - Modern Military History (3 credits)
Evolution of warfare in its political and social setting since the French Revolution. Discussion of both European and American military institutions.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3544 - World War II (3 credits)
Examines the origins, nature, and consequences of the Second World War in transnational perspective. Discussion of social, economic, political and diplomatic conditions that led to and shaped the conduct of the war. Engagement with diverse perspectives on the war and its implications through primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3554 - Age of Globalization (3 credits)
An examination of historical forces that have shaped patterns of globalization, with emphasis on the late twentieth and twenty-first centuries. Key themes: debates about the origins of globalization, causes and consequences of global inter-relatedness, influence of key people, events, and ideas on patterns of globalization, and the effects of disease, technology and environment on processes of globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3564 - The Cold War (3 credits)
Examines politics, society, and culture of the Cold War in transnational perspective. Discussion of origins of the Cold War and the emergence of superpowers; cultural, economic and territorial imperialism in the Cold War; the role of ideology; lived experience and the legacy of the Cold War. Engagement with diverse perspectives on the Cold War and its implications through primary and secondary source materials.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3594 - The Rise of Modern Latin America (3 credits)
Major themes and issues in Modern Latin American History. Discussion of the rise of Latin American nations, stressing the internal and external challenges new republics confronted during the nineteenth century and the opportunities and conflicts of the twentieth century.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3604 - Russia to Peter the Great (3 credits)
Russian history from the founding of Russia in the ninth century to the reign of Peter the Great in the early eighteenth century, with special attention to political developments, changes in society and culture and regional context.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3614 - Imperial Russia (3 credits)
Russian history from Peter the Great to the Revolution of 1917, with special attention to political developments, changes in society and culture, and the impact of the regional context.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3624 - Health and Illness in African History (3 credits)
Examines key subjects and themes in the history of health, medicine, and disease in African history. Topics include indigenous health systems, colonial medicine, and post-colonial health crises, including HIV/AIDS.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3644 - Twentieth-Century Russia (3 credits)
The history of the Soviet Union from 1917 to the present, with particular emphasis on collectivization, industrialization, ideology, international relations, and other factors that have determined the peculiar character of the Soviet state.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3654 - Arab-Israeli Conflict (3 credits)
Examines the origin and evolution of the Arab-Israeli Conflict from the late Ottoman era to present. Considers a variety of perspectives on the major events, places, people and history of the conflict, including the British Mandate period, independence, and post-1967. Connects the relationship between events and ideas in Palestine/Israel and their local, regional and global significance through analysis and synthesis of primary and secondary texts. Promotes interpretation of the conflict and potential solutions in written and oral form, both from the student's own and alternative points of view.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3664 - Revolutionary China (3 credits)
Ideological and institutional development of the Chinese Communist movement since 1920; emphasis on problems of historical change in modern China.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3674 - Topics in Chinese History (3 credits)
Examination of variable topics in Chinese history, ranging from the beginnings of civilization to the recent past. Examines the primary sources and histriographic debates of a particular issue. Explores the diversity within China and its relatiionship with the rest of the world. Can be repeated with different content up to 9 hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3694 - History through Film (3 credits)
This course introduces students to critical issues in history and representation, utilizing film to analyze central historical issues. The specific thematic content is variable. Course may be repeated for up to 9 credits.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3705 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3705

HIST 3706 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3706

HIST 3714 - War and Medicine (3 credits)
Examines the relationship between war and medicine. Focus on suffering and care during and after major conflicts, both on the battlefield and the home front. Emphasis on race, class, and gender.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3724 - History of Disease, Medicine, and Health (3 credits)
Development of Western concepts and institutions of disease, medicine, and health with emphasis on nineteenth century to present. Social construction of disease, and relationship between health and social, economic, and political structures. Special attention to roles of race, class, gender and ethical issues in medical care and research, and to the lived experience of suffering, treatment and healing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3734 - History of Modern Biology (3 credits)
Exploration of the history of biology during the nineteenth century and twentieth centuries, including developments in evolutionary biology, genetics and molecular biology, biology and race, and conservation biology. Emphasis on biology's reciprocal relationship with society, how it has helped shape ideas of race and ethnicity, and the ethical dilemmas it has generated.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3734

HIST 3744 - Social History of Film (3 credits)
This course introduces students to critical issues in the social history of film, examining the production and consumption of film in specific historical moments as well as the effects of film on society, culture, and politics. The specific thematic content is variable. May be repeated with different content for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

HIST 3754 - Public History (3 credits)
Investigation of the ways in which historians research, interpret, and present the past to the public.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3764 - Oral History: Methods and Practices (3 credits)
Explores the theory and methodology of oral history practice. Considers the use of oral history interviews in historical research, and explores questions of ethics, interpretation, and the construction of memory. Includes training in technical operations and a variety of interview techniques, transcription, and historical use of interviews.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3774 - Digital History (3 credits)
Develops skills and methods for researching and presenting history in a digital environment, with special emphasis on use of digital media as a tool for public historians.
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3914 - Critical Reading and Analysis in History (3 credits)
Develops critical reading skills in history. Demonstrates that historical knowledge is part of a scholarly conversation that grows and evolves over time. Assesses the critical role of interpretation in history, investigates historical controversies and debates, and develops skills to evaluate historiographical trends.
Prerequisite(s): HIST 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 3954B - Study Abroad (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

HIST 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4004 - Topics in Social and Cultural History (3 credits)
Selected topics in social and cultural history. May be repeated with different content. 3 other hours of history and junior standing required.
Prerequisite(s): HIST 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HIST 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ART 4014, EDCI 4014

HIST 4864 - Internship (6 credits)
Placement in historically relevant work in one of a variety of settings. These may include museum interpretation and management, archival management, editing, historic preservation and more. Demonstrate historical research and communication skills. Plan with others in a professional setting. Apply disciplinary skills to site-based contemporary problems and situations. Evaluate the experience. P/F only.
Instructional Contact Hours: (6 Lec, 6 Crd)

HIST 4914 - History Research Seminar (3 credits)
Variable topic, writing-intensive, capstone course for history majors. Provides in-depth knowledge of a specific historical subfield. Utilizes archival historical sources, online research databases, and existing literature to create an original work of historical scholarship. May be repeated with different content up to 6 hours. Junior standing or above required.
Prerequisite(s): HIST 3914 or HIST 3904
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

HIST 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HIST 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

History Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
HIST 1004	Introduction to History (or equivalent)	3
History Survey Sequence		
HIST 1025 & HIST 1026	Introduction to European History and Introduction to European History	
HIST 1115 & HIST 1116	History of the United States and History of the United States	
HIST 1215 & HIST 1216	Intro to World History and Intro to World History	
HIST 1515 & HIST 1516	History of Africa and History of Africa	
HIST 2165 & HIST 2166	and History of France	
HIST 2275 & HIST 2276	African-American History and African-American History	
HIST 2345 & HIST 2346	History of the Middle East and History of the Middle East	
HIST 2355 & HIST 2356	History of China and History of Modern China	
HIST 2374 & HIST 2384	Gods and Kings in Premodern India and Gandhi in the Making of Modern India	
HIST 2715 & HIST 2716	History of Technology and History of Technology	
HIST 2004	Historical Methods	3
HIST 3914	Critical Reading and Analysis in History	3
HIST 4914	History Research Seminar	3
Complementary Skills		
Select one of the following:		3
HIST 2604	Introduction to Data in Social Context	
HIST 2624	Topics in the History of Data in Social Context	
HIST 3754	Public History	
HIST 3764	Oral History: Methods and Practices	
HIST 3774	Digital History	
HIST 4014	History Lab: Creative Technologies, Hidden Histories, Informal Learning	
Any of the following Foreign Language courses: 2105 ,2106, 3105, 3106.		
The second introductory semester of a foreign language not used to satisfy the admissions foreign language requirement.		
Subtotal		15
Major Requirements		
Select two courses each in three of the following groups: [2]		18
HIST Group I (Empires, Colonialism, and Globalization)		
AINS 3684	Indigenous Peoples and World Politics	
HIST 1224	Mesoamerica and the Andes	
HIST 2165		
HIST 2166	History of France	
HIST 2346	History of the Middle East	
HIST 2364	History of Japan	
HIST 2384	Gandhi in the Making of Modern India	
HIST 2394	Tofu to Tikka: Food in Asian History	
HIST 2484	Modern Germany	
HIST 3004	Colonial America	
HIST 3014	The American Revolution	
HIST 3174	Native American History	
HIST 3274	The Greek City	
HIST 3314	The Later Roman Empire	
HIST 3234	The North American West	
HIST 3294	Roman Britain	
HIST 3364	The Age of Revolution and Napoleon	
HIST 3374	French Empire	
HIST 3554	Age of Globalization	
HIST 3594	The Rise of Modern Latin America	
HIST 3604	Russia to Peter the Great	
HIST 3614	Imperial Russia	
HIST 3864		
HIST Group II (Ideas, Traditions, and Cultures)		
HIST 2134	The Revolution Will Be Televised: Topics in History on TV	
HIST 2224	Ancient Greek and Roman Women	
HIST 2234	Classics in the Modern World	
HIST 2244	Cities of Rome	
HIST 2264	America in the 1960s	
HIST 2275	African-American History	
HIST 2276	African-American History	
HIST 2355	History of China	
HIST 2356	History of Modern China	
HIST 2374	Gods and Kings in Premodern India	
HIST 2494	Cities in History	
HIST 2504	Crime and Punishment in American History	
HIST 2514	U.S. Food History	
HIST 2544	U.S. South: Pre-Colombian to 1865	
HIST 2554	U.S. South: 1865 to Present	
HIST 3084	Recent America, 1917-Present	
HIST 3105	Women in U S History	
HIST 3106	Women in U S History	
HIST 3124	Murder in American History	
HIST 3134	Sports in American History	
HIST 3164	Sexuality in American History	
HIST 3214	History of Appalachia	
HIST 3224	History of Virginia	
HIST 3324	The Medieval World	
HIST 3334	The Renaissance World, 1350-1500	
HIST 3344	Early Modern and Reformation History, 1500-1650	
HIST 3504	The Age of The Crusades	

HIST 3694	History through Film	
HIST 3744	Social History of Film	
HIST Group III (Science, Technology, Environment, and Medicine)		
HIST 2054	Engineering Cultures	
HIST 2524	History of Agriculture	
HIST 2604	Introduction to Data in Social Context	
HIST 2624	Topics in the History of Data in Social Context	
HIST 2715	History of Technology	
HIST 2716	History of Technology	
HIST 3114		
HIST 3144	American Environmental History	
HIST 3624	Health and Illness in African History	
HIST 3705	History of Science	
HIST 3706	History of Science	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health	
HIST 3734	History of Modern Biology	
HIST Group IV (Conflict, War and Peace)		
HIST 1354	Conflict and Security in Modern East Asia	
HIST 2184	History of the Balkans	
HIST 2345	History of the Middle East	
HIST 2534	America at War	
HIST 3054	The American Civil War	
HIST 3254	The Vietnam War	
HIST 3284	The Roman Revolution	
HIST 3304	The World of Alexander the Great	
HIST 3484	Nazi Germany: History and Memory	
HIST 3494	The Holocaust	
HIST 3534	Modern Military History	
HIST 3544	World War II	
HIST 3564	The Cold War	
HIST 3644	Twentieth-Century Russia	
HIST 3654	Arab-Israeli Conflict	
HIST 3664	Revolutionary China	
Subtotal		18
Free Electives		
Select remaining hours in Free Electives to complete 120 credit hours required for the degree		36
Subtotal		36
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) [4]		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**114**

[1] Classes taken to fulfill the History Core Degree Requirements cannot be used to fulfill Pathways requirements.

[2] HIST 1014, HIST 1984, HIST 2984, HIST 3984, HIST 2104, HIST 2114, and HIST 2124 can be substituted to appropriate groups. Please see course schedule or advisor for more information.

[3] With the exception of courses used to justify History Core Degree Requirements, concepts 1a, 2, 3, 5f and 7 may be met with approved History courses.

[4] May complete 1F with ENGL 1105-ENGL 1106 First-Year Writing, or ENGL 1204H , or COMM 1015-COMM 1016 Communication Skills.

Satisfactory Progress Toward Degree

1. Suggested completion of the Pathways to General Education (45 credits) by end of junior year.
2. Suggested completion of 15 hours of history, including HIST 2004 Historical Methods, by semester in which you have attempted 72 credits.
3. GPA of 2.5 or above in all history courses by the end of semester in which you have attempted 18 credits of history.
4. GPA of 2.0 or above in all history courses by the semester in which you have attempted 96 credits.

Graduation Requirements

1. Minimum of 120 credit hours for the degree.
2. Minimum of 36 credits in history (maximum of 60 credits).
3. Completion of HIST 2004 Historical Methods and HIST 3914 Critical Reading and Analysis in History with a grade of C or above.
4. Students must earn a C- or above for a history course to count toward their major requirements.
5. Overall GPA and in-major GPA of 2.00 or above. The in-major GPA is calculated using all HIST courses.

Acceptable Substitutions

With the exception of courses used to satisfy History Core Degree Requirements, the following Pathways concepts may be met with approved History courses: 1A, 2, 3, 5F, 7.

Foreign Language Requirement

Foreign Language

Students who completed 3 years of a single foreign, classical, or sign language in high school have completed this requirement. Students who did not complete 3 years of a foreign, classical, or sign language in high school must complete one of the following:

- 2 years of a foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college. These 3 hours count towards the 120 required for graduation.
- Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college. These 6 hours do not count toward the 120 required for graduation.

History Major with Undergraduate Research/Thesis Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
HIST 1004	Introduction to History (or equivalent)	3
History Survey Sequence		
Select one of the following:		6
HIST 1025 & HIST 1026	Introduction to European History and Introduction to European History	
HIST 1115 & HIST 1116	History of the United States and History of the United States	
HIST 1215 & HIST 1216	Intro to World History and Intro to World History	
HIST 1515 & HIST 1516	History of Africa and History of Africa	
HIST 2165 & HIST 2166	and History of France	
HIST 2275 & HIST 2276	African-American History and African-American History	
HIST 2345 & HIST 2346	History of the Middle East and History of the Middle East	
HIST 2355 & HIST 2356	History of China and History of Modern China	
HIST 2374 & HIST 2384	Gods and Kings in Premodern India and Gandhi in the Making of Modern India	
HIST 2715 & HIST 2716	History of Technology and History of Technology	
HIST 2004	Historical Methods	3
HIST 3914	Critical Reading and Analysis in History	3
HIST 4914	History Research Seminar	3
Complementary Skills		
Select one of the following:		3
HIST 2604	Introduction to Data in Social Context	
HIST 2624	Topics in the History of Data in Social Context	
HIST 3754	Public History	
HIST 3764	Oral History: Methods and Practices	
HIST 3774	Digital History	
HIST 4014	History Lab: Creative Technologies, Hidden Histories, Informal Learning	
Any of the following Foreign Language courses: 2105 ,2106, 3105, 3106.		
The second introductory semester of a foreign language not used to satisfy the admissions foreign language requirement.		
Subtotal		21
Major Requirements		
Select two courses each in three of the following groups: [2]		18
HIST Group I (Empires, Colonialism, and Globalization)		
AINS 3684	Indigenous Peoples and World Politics	
HIST 1224	Mesoamerica and the Andes	
HIST 2165		
HIST 2166	History of France	
HIST 2346	History of the Middle East	
HIST 2364	History of Japan	
HIST 2384	Gandhi in the Making of Modern India	
HIST 2394	Tofu to Tikka: Food in Asian History	
HIST 2484	Modern Germany	
HIST 3004	Colonial America	
HIST 3014	The American Revolution	
HIST 3174	Native American History	
HIST 3274	The Greek City	
HIST 3314	The Later Roman Empire	
HIST 3234	The North American West	
HIST 3294	Roman Britain	
HIST 3364	The Age of Revolution and Napoleon	
HIST 3374	French Empire	
HIST 3554	Age of Globalization	
HIST 3594	The Rise of Modern Latin America	
HIST 3604	Russia to Peter the Great	
HIST 3614	Imperial Russia	
HIST 3864		
HIST Group II (Ideas, Traditions, and Cultures)		
HIST 2134	The Revolution Will Be Televised: Topics in History on TV	
HIST 2224	Ancient Greek and Roman Women	
HIST 2234	Classics in the Modern World	
HIST 2244	Cities of Rome	
HIST 2264	America in the 1960s	
HIST 2275	African-American History	
HIST 2276	African-American History	
HIST 2355	History of China	
HIST 2356	History of Modern China	
HIST 2374	Gods and Kings in Premodern India	
HIST 2494	Cities in History	
HIST 2504	Crime and Punishment in American History	

HIST 2514	U.S. Food History	
HIST 2544	U.S. South: Pre-Colombian to 1865	
HIST 2554	U.S. South: 1865 to Present	
HIST 3084	Recent America, 1917-Present	
HIST 3105	Women in U S History	
HIST 3106	Women in U S History	
HIST 3124	Murder in American History	
HIST 3134	Sports in American History	
HIST 3164	Sexuality in American History	
HIST 3214	History of Appalachia	
HIST 3224	History of Virginia	
HIST 3324	The Medieval World	
HIST 3334	The Renaissance World, 1350-1500	
HIST 3344	Early Modern and Reformation History, 1500-1650	
HIST 3504	The Age of The Crusades	
HIST 3694	History through Film	
HIST 3744	Social History of Film	
HIST Group III (Science, Technology, Environment, and Medicine)		
HIST 2054	Engineering Cultures	
HIST 2524	History of Agriculture	
HIST 2604	Introduction to Data in Social Context	
HIST 2624	Topics in the History of Data in Social Context	
HIST 2715	History of Technology	
HIST 2716	History of Technology	
HIST 3114		
HIST 3144	American Environmental History	
HIST 3624	Health and Illness in African History	
HIST 3705	History of Science	
HIST 3706	History of Science	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health	
HIST 3734	History of Modern Biology	
HIST Group IV (Conflict, War and Peace)		
HIST 1354	Conflict and Security in Modern East Asia	
HIST 2184	History of the Balkans	
HIST 2345	History of the Middle East	
HIST 2534	America at War	
HIST 3054	The American Civil War	
HIST 3254	The Vietnam War	
HIST 3284	The Roman Revolution	
HIST 3304	The World of Alexander the Great	
HIST 3484	Nazi Germany: History and Memory	
HIST 3494	The Holocaust	
HIST 3534	Modern Military History	
HIST 3544	World War II	
HIST 3564	The Cold War	
HIST 3644	Twentieth-Century Russia	
HIST 3654	Arab-Israeli Conflict	
HIST 3664	Revolutionary China	
Subtotal		18
Option Required Courses		
Select one of the following:		6
Research/Thesis Option		
Option A - Year-long senior or honors thesis		
HIST 4994	Undergraduate Research	
or HIST 4994	Undergraduate Research	
Option B - Semester-long project building on work completed in HIST 4914		
HIST 4994	Undergraduate Research	
or HIST 4994	Undergraduate Research	
Any 2000, 3000, or 4000-level HIST course not used to complete History degree core or major requirements		
Free Electives		
Select remaining credit hours of Free Electives		30
Subtotal		36
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
Select six hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) [4]		6
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 Classes taken to fulfill the History Core Degree Requirements cannot be used to fulfill Pathways requirements

2 HIST 1014, HIST 1984, HIST 2984, HIST 3984, HIST 2104, HIST 2114, and HIST 2124 can be substituted to appropriate groups. Please see course schedule or advisor for more information.

3 With the exception of courses used to justify History Core Degree Requirements, concepts 1a, 2, 3, 5f and 7 may be met with approved History courses.

4 May complete 1F with ENGL 1105-ENGL 1106 First-Year Writing, or ENGL 1204H, or COMM 1015-COMM 1016 Communication Skills.

1. Suggested completion of the Pathways to General Education (45 credits) by end of junior year.
2. Suggested completion of 15 hours of history, including HIST 2004 Historical Methods, by semester in which you have attempted 72 credits.
3. GPA of 2.5 or above in all history courses by the end of semester in which you have attempted 18 credits of history.
4. GPA of 2.0 or above in all history courses by the semester in which you have attempted 96 credits.

Graduation Requirements

1. Minimum of 120 credit hours for the degree.
2. Minimum of 36 credits in history (maximum of 60 credits).
3. Completion of HIST 2004 Historical Methods and HIST 3914 Critical Reading and Analysis in History with a grade of C or above.
4. Students must earn a C- or above for a history course to count toward their major requirements.
5. Overall GPA and in-major GPA of 2.0 or above. The in-major GPA is calculated using all HIST courses.

Foreign Language Requirement

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed this requirement. Students who did not complete 3 years of a foreign, classical, or sign language in high school must complete one of the following:
- 2 years of a foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college. These 3 hours count towards the 120 required for graduation.
- Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college. These 6 hours do not count toward the 120 required for graduation.
-

Human Development and Family Science

Our Website (http://www.hdfs.vt.edu)

Overview

The Department of Human Development and Family Science offers an undergraduate degree in Human Development. To earn this degree, students can major in Human Development or Early Childhood Development and Education (formerly Childhood Pre-Education). Human Development focuses on family relationships and of human development across the lifespan, human service skills, and public policies and issues that impact individuals and families. Early Childhood Development and Education (formerly Childhood Pre-Education) helps students prepare for careers involving young children. The department's mission is to understand and improve the lives of people of all ages in relationships, families, organizations, and communities.

The program participates in the University Honors Program.

The department offers graduate programs leading to an M.S. or Ph.D. with content options related to adult development and aging, child and adolescent development, family studies, and marriage and family therapy. Graduate students can earn the Graduate Certificate in Gerontology along with their degree or as Commonwealth Campus students (for more information, contact the Center for Gerontology, 237 Wallace Hall, (540) 231-7657). Graduate students can also earn the Graduate Certificate in Human Sexuality Studies along with their degree or as Commonwealth Campus students (for more information, contact the HDFS Department, 366 Wallace Hall, (540) 231-4794). (See the Graduate Catalog)

Human Development and Family Science

The degree in human development is for students interested in a wide variety of careers and graduate school programs. The option provides undergraduate majors with a theoretical and experiential grounding in child and adult development and in family and relational dynamics. Course work includes emphases on how individuals and families develop over the life cycle, on the critical issues and events that influence families, and on family transitions and dynamics. The curriculum also focuses on family diversity and social and public policies that affect individuals and their families. Through course work and field placement experiences, human development and family science students develop and practice skills and communication techniques for working with individuals, families and groups. In addition to course work within the Department of Human Development and Family Science, students take courses in related fields in order to gain a broad perspective on issues that affect human development and families. Students may tailor their studies to their particular professional goals and interests through the use of free electives. The experiential field study requirement, which integrates theory, research, and practice, is pivotal to students' career development. It increases students' professional communication and human service practice skills and helps narrow career interests.

Careers open to human development and family science graduates include: early childhood education, employment and job training services, health and wellness programs, housing services, income programs, mental health services, nutrition and meals programs, protective services, recreation programs, respite services, social services, substance abuse programs, volunteer programs, and child care services. Graduate and professional options that human development and family science graduates may consider include business, community health and public health, law, education, family studies, gerontology, marriage and family therapy, medicine and nursing, occupational therapy, physical therapy, psychology and sociology, public administration, rehabilitation, speech therapy, and social work.

Free Electives (Select 33-35 Credits)

Students are encouraged to consider the wide array of courses across the university curriculum as potential choices for electives to support their major. In consultation with an academic advisor, each student should confirm that prerequisite requirements have been met before enrolling in elective courses.

Satisfactory Progress

A student will be considered to have made satisfactory progress toward the degree when he/she has successfully completed the Pathways General Education requirements for Concepts 1F, 4, and one course for Concept 5F as well as HD 1004 Childhood and Adolescence, by the time the student has attempted 72 semester credits.

- Early Childhood Development and Education Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/human-development-family-science/early-childhood-dvlp-educ-bs/)
- Human Development Major (p. 1009)

Department Head: Paul Springer
Alumni Distinguished Professor: R. Blieszner
Professors: M. Dolbin-McNab, K. A. Roberto, L. Sands, T. Savla, C. L. Smith, and P. Teaster
Associate Professors: E. Grafsky, B. Howell, B. Katz, K.J. Kim, and J.M. Russon
Assistant Professors: K. Choi, C. B. Hornburg, T. Rice, C. Sanner, and R. Wesche
Associate Clinical Professor: J. Case Pease
Research Scientist: I. Bradburn
Senior Instructor: K. Gallagher and A. Gardner
Advanced Instructor: J. Culligan, M. Komelski, V. Lael, and I. Schepisi

Undergraduate Academic Coordinator: A. Lemon
Graduate Academic Coordinator: M. Wyatt
CLAHS Academic Advisor for HD majors: C. Ballard
CLAHS Academic Advisor for CPED and ECDE majors: S. Jarrett

Undergraduate Course Descriptions (HD)

HD 1004 - Childhood and Adolescence (3 credits)
Basic concepts related to human development. Emphasis on developmental theories and principles of physical, social, and emotional growth, development, and behavior of children, individually and within families and cultures, from conception through adolescence. Designed as a general survey Course for majors and non-majors.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 1014 - Introduction to Human Development & Family Science First Year Experience (1 credit)
Introduction to the Human Development and Family Science Department: majors, minors, and curriculum requirements and options. Introduction to academic skills and career exploration. Exploration of University programs and services that support students and promote student development.
Instructional Contact Hours: (1 Lec, 1 Crd)

HD 1134 - Introduction to Disabilities Studies (3 credits)
Introduction to concepts related to physical, intellectual, cognitive, and emotional disability, with a focus on disability as a social construct and lived experiences of people with disabilities across the lifespan. Exploration of texts, videos, and other created artifacts to evaluate concepts and models of disability.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 1984C - Special Study (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

HD 2004 - Adulthood and Aging (3 credits)
Introduction to adult development and aging (gerontology). Basic concepts, principles, theories, research methods and social issues of development from emerging adulthood through the end of life. Biopsychosocial analysis of issues affecting aging processes, including family dynamics. Consideration of social, economic, political and ethical issues in aging. Attention to multicultural perspectives and significant global challenges and opportunities related to aging around the world.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2014 - Integrative Practices for Health, Wellbeing, and Resilience (3 credits)
Theories of integrative (mind-body) health and wellbeing. Examination of multidimensional factors, including stress, personality, relationships, and social environment, as well as issues of identity and equity that influence health across the lifespan. Engagement in contemplative and evidence-based integrative health practices used for promoting health, wellbeing, and resilience. Attention given to ethical use and teaching of practice methods.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2104 - Quantitative Approaches to Community Research (3 credits)
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2104

HD 2304 - Family Relationships (3 credits)
Overview of basic concepts, principles, theories, and issues of development and change in family relationships. Topics include families in historical and contextual perspective, structural and relational diversity in families, and processes of relational development, maintenance, and dissolution in families.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2314 - Human Sexuality (3 credits)
Explores the diversity of human sexuality using global perspectives. Biological, historical, developmental, psychological, sociological and self-reflexive approaches. Interdisciplinary examination of the social constructions of sexuality and gender; the historical and contemporary theoretical perspectives and research on sex; the interactions of race, ethnicity, class, gender, sexual orientation, religion, ability, and nationality in shaping sexuality and family formation; the international commercialization of sex; the impact of violence and sexual coercion; the debates surrounding sexual ethics, unintended pregnancy, sex education, and biotechnology; the application of the scientific method, study designs, and methods of observation; the promotion of sexual and reproductive health across the lifespan; and the development of sexual practices, rituals, mythologies, belief systems and other cultural contexts for sexuality across time and around the world.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2335 - Principles of Human Services (3 credits)
2335: Basic concepts, techniques, and structure of the human services profession. Survey of client/family assessment and problem management. 2336: Advanced topics in human services focusing on: case management, crisis intervention, program administration, specialized interventions, ethics, and professional development.
Corequisite(s): 1004 or Pre: 1004.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2336 - Principles of Human Services (3 credits)
2335: Basic concepts, techniques, and structure of the human services profession. Survey of client/family assessment and problem management. 2336: Advanced topics in human services focusing on: case management, crisis intervention, program administration, specialized interventions, ethics, and professional development.
Prerequisite(s): HD 2335
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 3014 - Research Methods in Human Development (3 credits)
Critical thinking and problem-solving involved in applying methods of scientific inquiry to the field of human development and family science. Analysis of individuals, families, and groups. Topics include method of data collection, basic methods for displaying and analyzing data, and writing reports.
Prerequisite(s): HD 2004 and HD 2304 and (STAT 3005 or STAT 3615 or STAT 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3024 - Community Analytics (3 credits)
Application of data analytics concepts to community issues at local and global levels. Data sources, data quality, data representation and data ethics. Statistical analysis to improve community livability. Communication of data and statistics for community stakeholders. Evaluation of reports that use data. Sophomore standing or higher.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3114 - Issues in Aging (3 credits)
Investigates selected contemporary issues and measures potential solutions in adulthood and old age; family and friend relationships; work and retirement; political, legal, and economic issues; vulnerability related to gender.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3144 - Education of Exceptional Learners (3 credits)
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: EDCI 3144

HD 3214 - Infancy and Early Childhood (3 credits)
Theories, principles, and patterns of physical, cognitive, social and emotional development from conception to the early school years. Micro and macro environmental influences on development, including families and culture, are considered as they interact with genetic/biological determinants of development.
Prerequisite(s): HD 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3224 - Middle Childhood and Adolescence (3 credits)
Theories, principles, and patterns of physical, cognitive, social and emotional development from middle childhood to adolescence. Micro and macro environmental influences, including families and culture, on development as they interact with genetic/biological determinants of development.
Prerequisite(s): HD 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3234 - Child/Youth Community Services (3 credits)
Health and human service programs serving children, youth, and families to address life course development issues in the changing American family. Overview of child/youth care issues in areas such as poverty, health and healthcare, day-care services, school-based services, court services, child abuse and neglect, and children in residential settings. Methods of determining service eligibility, needs assessment techniques, translation of client data into a plan for community-based programs and services, and procedures for maintaining quality assurance.
Prerequisite(s): HD 1004 and HD 2304 and HD 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3254 - Curriculum in Early Childhood (3 credits)
Supervised experience in planning and implementing emergent, play-based learning experiences for young children; examination of the role of the teacher; exploration of early childhood curricular design and materials suitable for addressing milestones of child development based on theory and research; utilization of approaches related to sharing child-specific information with families.
Prerequisite(s): HD 1004 and HD 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3304 - Advanced Helping Skills (3 credits)
Helping skills used in human services settings. Case management, evaluating crisis situations, and approaches to individual and family assessment.
Prerequisite(s): HD 2335 and HD 2336
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HUM 3464, SOC 3464, UAP 3464

HD 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

HD 3954 - Study Abroad (1-9 credits)
Instructional Contact Hours: (1-9 Lec, 1-9 Crd)

HD 3954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

HD 3954G - Study Abroad (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

HD 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4304 - Human Services Administration (3 credits)
Issues, functions, and responsibilities involved in developing, implementing, and evaluating family and human services programs.
Prerequisite(s): HD 3234 or HD 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4324 - Advanced Family Relationships (3 credits)
Investigation of challenges, stresses, and crises experienced by diverse, complex families over the life course; protective factors and resilience; coping strategies; prevention and intervention; public policies. Pre: Junior standing.
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4324H - Advanced Family Relationships (3 credits)
Investigation of challenges, stresses, and crises experienced by individuals and families; protective factors and resilience; coping strategies; prevention and intervention; public policies.
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4334 - Perspectives On Addiction and Family Systems (3 credits)
Intra-personal and inter-personal dimensions of compulsive- addictive patterns manifested in the context of the family system. Reciprocal interaction between families and other systems. Junior standing required.
Prerequisite(s): HD 2304 or HD 2314
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4354 - Family, Law, and Public Policy (3 credits)
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families.
Prerequisite(s): HD 1004 and HD 2335 and HD 2336 and HD 2004 and HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4354H - Family, Law, and Public Policy (3 credits)
Theoretical and substantive issues that relate to the development and implementation of family policies. Implications of political culture and family legislation for the well-being of children and their families.
Prerequisite(s): HD 1004 and HD 2335 and HD 2336 and HD 2004 and HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4364 - Gender And Family Diversity (3 credits)
Examination of the changing character of individual and family diversity, as related to the intersections among gender, race, class, sexuality, age, and ability. Junior standing required
Prerequisite(s): HD 2304
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4714 - Senior Capstone Seminar (3 credits)
Intensive learning experiences in critical thinking and analysis of human development and family science. Opportunities to demonstrate breadth of learning while developing leadership skills and honing professional competencies. Topics include leadership and team development, problem solving, grant writing, program evaluation, and electronic portfolios. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

HD 4964 - Field Study (1-19 credits)
Prerequisite(s): HD 1004 and HD 2004 and HD 2335 and HD 2336
Instructional Contact Hours: Variable credit course

HD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Human Development Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
HD 1004	Childhood and Adolescence	3
HD 2004	Adulthood and Aging	3
HD 2304	Family Relationships	3
HD 2335	Principles of Human Services	3
HD 2336	Principles of Human Services	3
HD 3014	Research Methods in Human Development	3
HD 4714	Senior Capstone Seminar	3
Major Requirements		
HD 1014	Introduction to Human Development & Family Science First Year Experience	1
HD 4324	Advanced Family Relationships	3
HD 4964	Field Study	6
Human Development Electives		
Select three of the following, at least one must be at the 3000 or 4000 level:		9
HD 1134	Introduction to Disabilities Studies	
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience	
HD 2314	Human Sexuality	
HD 3024	Community Analytics	
HD 3114	Issues in Aging	
HD 3214	Infancy and Early Childhood	
HD 3224	Middle Childhood and Adolescence	
HD 3234	Child/Youth Community Services	
HD 3254	Curriculum in Early Childhood	
HD 3304	Advanced Helping Skills	
HD 4334	Perspectives On Addiction and Family Systems	

HD 4994	Undergraduate Research	
Disciplinary Breadth Electives		
Select two of the following:		6
CONS 2304	Consumer and Family Finances	
EDCI/HD 3144	Education of Exceptional Learners	
HUM/RLCL 3204	Multicultural Communication	
HUM/AHRM/APS/GEOG/HD/SOC/UAP 3464	Appalachian Communities	
PSYC 2054	Psychology of Personality	
PSYC 2084	Social Psychology	
SOC 2024	Sociology of Race and Ethnicity	
SOC 2304	Individual In Society	
SOC 3004	Social Inequality	
SOC 3714	Sociology of Aging	
SOC 4714	Sociology of Mental Illness	
WGS 1824	Introduction to Womens and Gender Studies	
WGS/SOC/AFST 2264	Race, Class, Gender, and Sexualities	
Subtotal		46
Free Electives		
Select 29 credits of free electives		29
Subtotal		29
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) [1]		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSYC 1004	Introductory Psychology	3
SOC 1004	Introductory Sociology (Double counts for Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07))	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		
MATH 1014	Precalculus with Transcendental Functions (5F)	3
or MATH 1025	Elementary Calculus	
or MATH 1225	Calculus of a Single Variable	
Select one of the following:		
STAT 3604	Statistics for Social Science (5A)	3
or STAT 3615	Biological Statistics	
Select three additional credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) or Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
CONS 2304	Consumer and Family Finances (Recommended) [2]	
HD 3024	Community Analytics (Recommended)	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) [1]		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SOC 1004	Introductory Sociology [3]	3
Subtotal		45
Total Credits		**120**

1. Students in the HD major pursuing the minor in Disability Studies (DST) can fulfill Pathways Concept 2 and/or 6d from the DST minor.
2. CONS 2304 Consumer and Family Finances, or HD 3024 Community Analytics, is recommended because these courses fulfill this Pathways requirement and offer content relevant to the HD major.
3. SOC 1004 Introductory Sociology, fulfills Pathways Concept 3 and 7. Students who take one of these courses covering Pathways Concept 7 will only need to take 42 credit hours to fulfill their required Pathways courses, instead of 45.

Satisfactory progress toward the degree is defined as successful completion of HD 1004 Childhood and Adolescence and Pathways Concept 1f, 4, and 5f by the time the student has attempted 72 semester hours.

Graduation Requirements

Minimum University GPA is 2.0. Minimum in-major GPA is 2.0. All core courses and major courses count toward the in-major GPA. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree.

In addition to satisfying all University, Pathways, and Human Development major requirements, students will complete sufficient Free Electives to total 120 credit hours.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count towards the minimum credit hours required for graduation.

International Studies

Our Website (http://www.liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html)

Overview

The International Studies Program offers five (5) majors, leading to a **Bachelor of Arts degree in International Studies (BAIS)**. The majors of the BAIS degree are:

- International Studies (IS)
- International Relations (IREL)
- National Security & Foreign Affairs (NSFA)

- Environment, Development, and Global Economy (EDGE)
- European & Transatlantic Studies (EUTS)

Students pursuing these majors are prepared to continue their studies in graduate or law school or immediately apply their skills and knowledge in various professional settings because of the broad applicability of the range of intellectual perspectives and theoretical traditions they are trained in, the global cultural learning to which they are exposed, the competencies they develop in research, writing, and analytical thinking, and the proficiencies they gain in critical foreign languages. Rooted in a strong liberal arts curriculum, the International Studies Program prepares students to enter careers in government service (Department of State, Department of Defense, Department of Homeland Security, the intelligence community), Foreign Service, think tanks, teaching, journalism, international governmental and non-governmental organizations, and global companies based in Virginia, nationally, and internationally.

Majors

Students may choose to pursue one of the five majors offered by the International Studies Program. In this case, no course can double count within or between International Studies-related majors with the exception of IS 1004 Nations and Nationalities,IS 1034 Introduction to International Studies and Political Science IS 2004 Research and Writing in International Studies, IS 2054 Introduction to World Politics, IS 2064 The Global Economy and World Politics, IS 2084 The Evolution of World Order, IS 3115 Selected World Problems, and IS 3116 Selected World Problems .

All students who wish to obtain a major offered by the International Studies Program must complete:

1. the Core Curriculum requirements of the College of Liberal Arts and Human Sciences;
2. the Core Curriculum requirements of the Bachelor of Arts in International Studies (BAIS) degree; and
3. a set of major requirements and elective courses associated with each of the five majors.

The *International Studies (IS)* major is the broadest and most interdisciplinary major of the BAIS degree that offers students the opportunity to learn about foreign cultures, religions, languages, economics, and history. The curriculum is highly interdisciplinary in orientation and is designed to introduce students to a wide range of perspectives in understanding international politics, foreign cultures, and global processes. Whether or not students pursue careers directly related to world affairs, the understandings gained in this major provide students with a broad perspective on the world and the United States' place in it. In addition to major requirements in international studies and political science, students pursuing this major complete a wide range of courses in economics, geography, foreign languages, history, religion and culture, sociology, and other disciplines.

The *International Relations (IREL)* major focuses on the analysis of the political, societal, cultural, ethical, and normative aspects of international relations, as well as offering students a rigorous international and comparative perspective on the contemporary global system. It emphasizes a solid grounding in the methods of analysis used in the social sciences and the field of international relations to help students think critically about international phenomena and analyze the choices and challenges that arise in this arena. It seeks to foster creative thinking about complex global problems and produce competitive graduates and enlightened citizens who possess the necessary knowledge and skills that allow them not only to successfully pursue careers in their chosen field but, most importantly, serve their communities and the nation.

The *National Security and Foreign Affairs (NSFA)* major offers students expertise and understanding of the broad range of threats to national and global security in the 21st century and equips them with the necessary knowledge and skills that allow them to successfully pursue careers in diplomacy and international organizations. The National Security and Foreign Affairs (NSFA) major analyzes the role of diplomacy in the management of world affairs and examines in-depth U.S. grand strategy and foreign policy; the current and future global geopolitical environment that affect the U.S. and its interests; the ends, ways, and means that impact the use of military force; the role and impact of economic power on world affairs; the informational issues that contribute to the holistic implementation of strategy, and counterterrorism and homeland security. It is designed to connect theory and practice thereby providing a hands-on, practical approach to the field that equips students with the tools to analyze threats that challenge U.S. security both at home and abroad.

The *Environment, Development, and Global Economy (EDGE)* major is a successor to the former International Public Policy major. EDGE is designed to help students analyze the choices and challenges that arise in the global economic system and equip them with a better understanding of how states and societies can pursue their economic goals in an environmentally and socially sustainable manner. It emphasizes the role of international organizations in the global economy and in development, as well as help students think critically about globalization and its impact on both developed and developing countries, sustainable development, and the fight against global poverty. Its purpose is to relate theory to practice and provide students with a breadth of knowledge and training in the various facets of sustainable international development and the sub-fields of governance and political economy, environment and development, and international public health. It seeks to prepare students for a fast-growing number and variety of careers in the planning, implementation, and evaluation of development programs, working for governments, international organizations, NGOs, and private companies.

The *European & Transatlantic Studies (EUTS)* major has been designed in response to the growing need for a new generation of scholars and analysts to address issues pertaining to Europe and the relations between the European Union and the United States (transatlantic relations). The purpose of the European & Transatlantic Studies program is to provide its students with the knowledge, skills and competencies necessary to enable them to pursue successful careers both in the public and private sector. Students pursuing a major in European & Transatlantic Studies will examine the historical, political, security, geostrategic, economic (trade, finance, and business), and societal (ethnic, cultural, and religious) aspects of European and transatlantic affairs. They will also gain competence in at least one foreign language. The study of Europe includes the following sub-regions: Western, Central & Eastern Europe; Russia and Eurasia; the Balkans and the Mediterranean region (North Africa & the Middle East), and the broader transatlantic space (relations between Europe, Africa, North America, and Central & Latin America).

Please see http://liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html for more information.

Major Requirements

The curriculum is designed to provide foundational and development courses, major-specific study, and a capstone experience. Students are introduced to concepts early in the undergraduate career, and the curriculum allows them to build knowledge and skills as they work on increasingly complex tasks. They also develop skills in written, spoken, and visual communication across their studies in the major. At the foundational level, students in every major are required to take the same introductory courses. Then students move into major-relevant specialized courses, and finally join together in the senior year to work on a capstone experience.

Minor Requirements

The International Studies Program offers eight (8) minors, open to all majors at Virginia Tech.

- Minor in Global Engagement (GLBE)
- Minor in International Studies (IS)
- Minor in International Relations (IREL)
- Minor in National Security & Foreign Affairs (NSFA)
- Minor in Global Development and Political Economy (GDPE)
- Minor in European Studies (EUST)
- Minor in European Engagement (EURE)
- Minor in Transatlantic Studies (TRST)

For the 18-hour minor, students enroll in three required courses and choose other three courses from the minor elective list. Please see http://liberalarts.vt.edu/academics/majors-and-minors/international-studies-major.html for details.

The minor in *Global Engagement (GLBE)* offers a "hands on" – "minds on" approach to the understanding of global affairs. Adopting an experiential learning approach, this minor seeks to encourage and reward Virginia Tech students who wish to explore and study the "international" through a variety of educational tools, such as study abroad, in-class simulations, participation in various international organizations models (e.s., Model UN, Model NATO, Model OAS), field studies, undergraduate research, internships and externships, and educational programs and engagement opportunities offered by U.S. national federal agencies and other organizations, such as the Department of State (e.s., Diplomacy Lab and Foreign Policy Classroom), the Council of Foreign Relations, and the U.S. Institute for Peace.

The minor in *International Studies (IS)* offers students an interdisciplinary approach to the study of global affairs. The purpose of the program is threefold: first, to supplement the knowledge and skills that students have acquired through their major field of study with knowledge about the global political and economic system and the global forces and processes that shape our daily lives; second, to further students' critical and analytical skills; and third, to create knowledgeable and enlightened citizens and global leaders.

The minor in *International Relations (IREL)* is designed to offer students a rigorous international and comparative perspective on the contemporary global system. It focuses on the changing political and cultural relations within the international system in the modern era, exploring how global, regional, and domestic factors influence relations between actors on the world stage. Students are equipped with both the foundational skills and specific knowledge necessary to analyze the choices and challenges that arise in this arena. The program seeks to provide a hands-on, practical approach to the field that would equip students with the analytic tools, language expertise, and cross-cultural understanding necessary to pursue successful careers in government, Foreign Service, and international organizations.

The minor in *National Security and Foreign Affairs (NSFA)* analyzes the role of diplomacy in the management of world affairs and provides a hands-on, practical approach to security analysis that would equip students with the tools to analyze threats that challenge US security both at home and abroad. The program seeks to supplement the knowledge and skills that students have acquired through their major field of study with expertise and understanding of the broad range of threats to national and global security in the 21st century, as well as to equip students with the necessary knowledge and skills that would allow them to successfully pursue careers in diplomacy and international organizations.

The minor in *Global Development and Political Economy (GDPE)* is a unique interdisciplinary minor that exposes students to the study of the global political economy, global economic processes, and challenges of sustainable development. It is designed for students who wish to develop the analytical and leadership skills necessary to formulate and advocate policy on key international issues of social and environmental sustainability, the critical analysis of global processes, and issues of global equity and justice. It seeks to provide students with a detailed and systematic understanding of how political institutions, processes, and public policies operate in world affairs. The program brings together the academic study of international relations with theoretical description and analysis of global social and economic processes and formal methods of social and economic analysis. The program seeks to prepare students for a fast-growing number and variety of careers in the planning, implementation, and evaluation of development programs, employment with governments, international organizations, NGOs, and private companies.

The minor in *European Studies (EUST)* seeks to provide students with knowledge, skills and competencies pertaining to European affairs to enable them to pursue successful careers both in the public and private sectors. It focuses on the study of the historical, political, security, geostrategic, economic (trade, finance, and business), and societal (ethnic, cultural, and religious) aspects of European affairs. The study of Europe includes the following sub-regions: Western, Central & Eastern Europe; Russia and Eurasia; the Balkans and the Mediterranean region (North Africa & the Middle East). This minor also focuses on the study of the relations between the European Union and the various world regions, s well as its relations with major great powers (e.s., the United States, Russia, and China) and international organizations (e.s., the United Nations, the World Trade Organization (WTO), and the IMF/World Bank).

The experiential learning minor in *European Engagement (EURE)* offers a "hands on" – "minds on" approach to the understanding of European affairs. It seeks to encourage and reward Virginia Tech students who wish to explore and study European affairs through a variety of educational tools, such as study abroad, in-class simulations, participation in various European organizations models (e.s., Model NATO, Model European Council, etc.), field studies, undergraduate research, internships and externships, and educational programs and engagement opportunities offered by the European Union and its Diplomatic Delegation in Washington DC, as well as by NATO and the Atlantic Council of the United States.

The minor in *Transatlantic Studies* equips students with knowledge about the political, economic, security, religious, and cultural ties binding European states and the states in the Americas (especially North America) together. Whether individual European countries, individual EU

Members States or the European Union as a whole are all seen as the United States' strategic allies or competitors, it is important for students interested in pursuing careers in the Federal Government (especially at the Department of State, the Department of Defense and the Intelligence Community), as well as in the private sector (banking, multinational companies, consulting firms, etc.) to learn about the issues that bound Europe and the United States together.

Satisfactory Progress Toward the Degree

University policy requires that students demonstrate their progress toward the degree by meeting minimum requirements.

To proceed satisfactorily toward a degree, students who pursue the majors in Environment, Development, and Global Economy (EDGE – formerly the major in International Public Policy), International Relations (IREL), International Studies (IS), and National Security & Foreign Affairs (NSFA) must complete IS 1004 Nations and Nationalities, IS 1034 Introduction to International Studies and Political Science, IS 2004 Research and Writing in International Studies, IS 2054 Introduction to World Politics, IS 2064 The Global Economy and World Politics, IS 2084 The Evolution of World Order and Foreign language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in-major GPA of 2.0.

To proceed satisfactorily toward a degree, students who pursue the major in European & Transatlantic Studies (EUTS) must complete IS 1004 Nations and Nationalities, IS 1024 Comp Gov & Politics, IS 1034 Introduction to International Studies and Political Science, IS 1104 Introduction to European Studies, IS 2004 Research and Writing in International Studies, HIST 1026 Introduction to European History, IS 2084 The Evolution of World Order, HIST 2114 Topics and Critical Issues in European History and Foreign Language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Students who fall below the standard for either the overall GPA or the in-major GPA will have one semester to regain the required GPA standards. A student who fails to make satisfactory progress toward degree after that semester will be disallowed from continuing in the major.

- Environment, Development, and Global Economy Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/international-studies/environment-development-and-global-economy-major/)
- EUropean & Transatlantic Studies Major (p. 1023)
- International Relations Major (p. 1026)
- International Studies Major (p. 1029)
- National Security & Foreign Affairs Major (p. 1034)

Director of International Studies: Dr. Besnik Pula

First-year and incoming transfer student advisor: Jennifer Hanratty

Sophomore, junior, and senior student advisor: Phoebe Peterson

For a full list of faculty, please see the Department of Political Science (p. 1078).

Undergraduate Course Descriptions (IS)

IS 1004 - Nations and Nationalities (3 credits)
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1004

IS 1024 - Comp Gov & Politics (3 credits)
Government and politics of selected countries outside the United States; nature of politics and government, types of political systems, linkages of people and governments, and current political issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1024

IS 1034 - Introduction to International Studies and Political Science (3 credits)
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing process.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1034

IS 1104 - Introduction to European Studies (3 credits)
Multidisciplinary analysis of core issues and topics in European studies. Current affairs, politics, economics, culture, religions, society and history. Regional and individual country perspectives. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 1114 - Introduction to Transatlantic Studies (3 credits)
Multidisciplinary analysis of core issues and topics in transatlantic studies. Origins and evolution of transatlantic interactions. Historical, political, economic, cultural (including language and literature), civilizational, religious, and societal ties binding Europe and the Americas. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 1114

IS 1204 - Topics in Global Dialogues (1 credit)
Examination of the impact of culture in world politics. Topics under examination include: culture and global diversity; culture, identity, and order in world politics; international conflict and intercultural relations. Extensive use of case studies. May be repeated twice with different content for a maximum of three (3) credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours
Course Crosslist: PSCI 1204

IS 2004 - Research and Writing in International Studies (3 credits)
Introduces the research and writing process in the field of International Studies. Addresses topics such as selecting and planning a research project, conceptualizing a research design, gathering and analyzing data, interpreting the results and writing a report. Prioritizes research within a framework of rigorous, well-rounded and thorough practices of research ethics. Emphasizes intercultural and diverse research and practices.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2034, PSCI 2034

IS 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2044, PSCI 2044

IS 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2054, PSCI 2054

IS 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2064, PSCI 2064

IS 2084 - The Evolution of World Order (3 credits)
A historical and comparative study of states systems (i.e, ancient, medieval, modern, and contemporary states system). Emphasis on the globalization of the European states system, its various aspects (political, economic, cultural, religious, civilizational, and technological) and its implications for contemporary world order (i.e., the question of human equality and the impact of colonialism and post-colonialism on the question of social, political and economic justice).
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2084

IS 2104 - Europe Country Analysis (3 credits)
Examination of the politics, economics, culture, society, population patterns, and history of individual European countries. Impact of individual European states' domestic affairs on their respective European sub-regions and Europe as a whole. Analysis of intra-European regional developments. Examination of differing country perspectives on European integration.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2104

IS 2114 - Transatlantic Political Frameworks (3 credits)
Examination of transatlantic political, security and economic institutions, such as the Organization for Economic Cooperation & Development (OECD), the North Atlantic Treaty Organization (NATO), and the Organization for Security & Cooperation in Europe (OSCE). Impact of domestic politics and external policies on the operation of transatlantic institutions. US-European relations and their impact on transatlantic institutions and European security. Bilateral political links between European and North America States (i.e., the UK-US- Canada, and France-Canada) and their impact on transatlantic relations and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2114

IS 2134 - Geography of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2134, PSCI 2134

IS 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2224, PSCI 2224

IS 2474 - Religion and Violence (3 credits)
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2474

IS 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2484, RLCL 2484

IS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 3004 - Professionalism and Careers in Political Science and International Studies (3 credits)
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3004

IS 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3034, PSCI 3034

IS 3044 - The Politics of Internet Governance (3 credits)
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3044

IS 3054 - The Dark Web and Threat Analytics (3 credits)
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3054

IS 3064 - Food Politics (3 credits)
Focuses on how scholars, pundits, citizens, and policymakers think about food on local, national, and global scales. Explores various ways of producing, distributing, and consuming food and how they are implicated in specific organizations of power and possibility. Examines how food, and the discourses surrounding food, help structure understandings of a variety of issues, such as identity, property, labor, gender, race, responsibility, and death.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3064

IS 3104 - Security Studies: Theories and Concepts (3 credits)
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3104

IS 3114 - Global Security (3 credits)
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3114

IS 3115 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3115

IS 3116 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3116

IS 3125 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3125

IS 3126 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 3125 or PSCI 3125
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3126

IS 3134 - Global Conflict and War (3 credits)
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the present and future of war.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3134

IS 3135 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3135

IS 3136 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3136

IS 3144 - Global Governance and Public Policy (3 credits)
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crime. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non- governmental organizations, coalitions and corporations in global public policy-making.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3144

IS 3154 - Topics in Global Public Policies (3 credits)
Examines in depth selected global public policies pertaining to health, energy, environment, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) or (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 3154

IS 3164 - Global Trade: Structures and Policies (3 credits)
Focuses on the operations of global trading system and its structure, theories of trade in international political economy, world trading powers and international and regional trade international organizations such as the World Trade Organization (WTO), the European Union (EU), the United States-Mexico-Canada Agreement (USMC), European Union (EU), United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and their policies.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3164

IS 3165 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance - Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3165

IS 3166 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nationa Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance - Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3166

IS 3174 - Monetary Foundations of the World Economy (3 credits)
Focuses on the evolution the operations of global and structure of regional international organizations such as the International Monetary Fund (IMF) and World Bank, the global financial and monetary order. Theories of the global and monetary system in international political economy, the structure of world finance, international financial institutions, the rise of new financial powers in the world economy, central banking, monetary and financial regulation and financial crises and policy responses.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3174

IS 3175 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3175

IS 3176 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3176

IS 3184 - Human Security (3 credits)
Introduces the field of human security and examines the conceptual, theoretical, and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and discusses its future.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3184

IS 3194 - Nuclear Strategy & Politics (3 credits)
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3194

IS 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3344, UAP 3344

IS 3374 - The Politics of Energy (3 credits)
Critical and humanistic perspectives of energy and its global problems. Politics and ethics of fuel extraction, distribution, and consumption across cultures and histories. Energy narratives, discourses, and aesthetics in the formation of political identities. Energy and the rise of modern democracy and global capitalism, with an emphasis on the energy dimensions of climate justice. Pre: Junior Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3374

IS 3384 - Politics of Global and Comparative Migration (3 credits)
Theories and politics of international migration. How policies in destination, transit, and origin countries influence migration. Why governments adopt the migration policies they do. Impacts of global, regional, and national politics and policies on migration among countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3384

IS 3394 - Comparative Politics of Immigrant Inclusion (3 credits)
Theories of citizenship applied across levels of government. Comparative policies for political, social, and military inclusion. Explanations for variations in policies supporting citizenship and inclusion across countries. Explanations for differences among immigrants' political inclusion across countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3394

IS 3514 - Latin American Government and Politics (3 credits)
Introduction to the political systems of Latin American countries, including legislative-executive relations, interest groups, political parties, electoral systems, political violence, and socio-political development.
Prerequisite(s): PSCI 1014H or PSCI 1014 or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3514

IS 3515 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3515

IS 3516 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3516

IS 3524 - Politics of Post-Communist Systems (3 credits)
Institutions, party structures, political economy, elite politics, ethnic conflicts, leadership dynamics, and mass political behavior in Russia and other post-communist political systems.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3524

IS 3534 - African Government and Politics (3 credits)
Survey of major concepts and themes in the study of African politics and development: analyses of the state, political institutions, social forces, democratization, sustainable development, issues of contemporary African politics.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3534

IS 3554 - Comparative Political Economy (3 credits)
Economic policies and collective choice processes of pre-industrial, industrializing, and advanced industrial states; problems and crises of industrial development, economic distribution, and technological transfer in the transition from an agrarian to advanced industrial society.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3554

IS 3574 - Government and Politics of Japan (3 credits)
Introduction to governmental institutions, patterns of political organization and behavior, and key policies of the Japanese political system.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3574

IS 3584 - Governments and Politics of Asia (3 credits)
Introduction to governmental institutions, political behavior, and social and economic policy approaches of China and other selected countries in the Asian region.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3584

IS 3594 - Topics in Middle East Politics and International Relations (3 credits)
Government and politics of Middle Eastern states. Religion, culture and society in the Middle East. Nationalism and Middle East politics. Regional conflicts and regional security. International relations of the Middle East. Great powers and Middle East politics. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1024 or PSCI 1024 or IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3594

IS 3615 - International Relations (3 credits)
Structure and development of the modern international system, theories of international policies, international law; international organizations.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3615

IS 3616 - International Relations (3 credits)
Structure and development of the modern international system; theories of international policies; international law; international organizations.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3616

IS 3624 - Foreign Policy and Diplomacy (3 credits)
Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses type of diplomacy and diplomatic methods.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3624

IS 3625 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President; Congress; press; public; and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Lenninist ideology.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 1024H or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3625

IS 3626 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3626

IS 3634 - Human Rights: Global Issues (3 credits)
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3634

IS 3644 - Religion in the Middle East (3 credits)
Critical issues in religion in the Middle East. Competing methods for analyzing religion in the Middle East. Key concepts relating to religion and inter-religious relations in the Middle East such as minority, majority, tolerance, citizenship, and family law. Critical thinking about the relationship between Islam and other religions with particular reference to Muslim-Jewish and Muslim-Christian relations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARBC 3644, RLCL 3644

IS 3694 - Far-right Violence in the United States (3 credits)
Assessment of theoretical and conceptual foundations to understand the rise of far-right violence in the United States. Identification of causes of radicalization into the far-right. Comparison of case studies of historical and contemporary far-right violence. Evaluation of differences and similarities in historical and contemporary case studies. Appraisal of successful responses to far-right violence.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3694

IS 3704 - National Security Strategy (3 credits)
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3704

IS 3734 - National Security (3 credits)
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3734

IS 3795 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3795

IS 3796 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3796

IS 3804 - European Integration (3 credits)
Analysis of the process of industrial, political, legal, economic, social and cultural integration of states in Europe as a whole or within a European sub-region. History and theories of European integration. Examination of various European organizations whose actions reflect different approaches to and different degrees of integration in Europe.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3804

IS 3814 - The European Union: Institutions and Policies (3 credits)
Evolution, organizational structure, political dynamics, and decision-making mechanisms of the European Union. Major internal and external EU policies such as foreign, security and defense policy, economics, Single Market, and monetary union.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3814

IS 3824 - European Union's Foreign and Security Policy (3 credits)
The European Union (EU) as an actor in the foreign, security and defense policy fields. The external relations of the EU and its role in world affairs. The institutional arrangements of EU external relations and EU activity in policy areas including human rights, peacekeeping, environmental governance, trade, and economic development.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3824

IS 3825 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3825

IS 3826 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3826

IS 3834 - European Security Governance (3 credits)
Structure and function of major European security organizations, such as the North Atlantic Treaty Organization (NATO), the European Union (EU), the Organization for Security and Cooperation in Europe (OSCE), and the Collective Security Treaty Organization (CSTO). In-depth analysis of those organizations' role in the European security architecture. Examination of inter-organizational cooperation in addressing European security issues and conflicts.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3834

IS 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3844, PSCI 3844

IS 3854 - European Political Economy (3 credits)
The European Union's major institutions and policies relating to economic and monetary union and trade. Monetary integration, fiscal and economic policy cooperation, financial integration (including the banking union), the single market and the common commercial policy, the common agricultural policy and the EU's regional policy. The internal structure and organization of the European political economy and the external dimension of Europe and its impact on global economics, ranging from the World Trade Organization to EU enlargement and the Developing World.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3854

IS 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 3874, PSCI 3874

IS 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3884, SOC 3884

IS 3894 - Transatlantic Relations Since 1945 (3 credits)
Analysis of the post- World War II transatlantic relations. Origins and historical context of the transatlantic partnership. Impact of the changing security context and domestic politics on the evolution of transatlantic relations. Causes of tensions and discord between the United States and its European allies and their impact on European security and world order.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3894

IS 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3914, PSCI 3914

IS 3924 - Theories of Transatlantic Relations (3 credits)
Examination of historical, cultural, and civilizational approaches to the study of ties binding Europe and North America. Exploration of the role of identity and national interests in the analysis of transatlantic relations. Investigation of the causes of tensions between the United States and its European allies and the management of these tensions.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3924

IS 3934 - NATO & European Security (3 credits)
Origins and evolution of the North Atlantic Treaty Organization (NATO). Organizational structure, decision and policy-making, missions, and operations. NATO and the European Union's Common Foreign and Security policy (CFSP) and Common Security and Defense Policy (CSDP). Impact of domestic politics and external policies on the operation of NATO and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3934

IS 3944 - International Enrollment (0 credits)
Participation in an approved study abroad program without direct supervision of the Va Tech faculty but with required enrollment in an approved program of study in a foreign university.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944S - International Enroll Special 3 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents three billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944T - International Enroll Special 4 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents four billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3944U - International Enroll Special 6 (0 credits)
Participation in an approved Study Abroad program without direct supervision of the Virginia Tech faculty but with required enrollment in an approved program of study in an international university. Course represents six billable hours and no academic credit.
Instructional Contact Hours: (0 Lec, 0 Crd)

IS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4004 - Seminar in International Studies (3 credits)
Interdepartmental seminar to synthesize and articulate basic assumptions, theories, and methods of international studies. Senior standing in IS and instructor consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4014 - International Development (3 credits)
Utilizes development, gender, and social theory to examine the impact of aid programs on communities in the Third World. Analyzes such issues as the impact of development projects in agriculture, natural resources, and employment on the local people, the impact of aid on women; and the policies and administrative structures that direct the world of international development.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4024 - Seminar in Diplomacy and Security (3 credits)
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4024

IS 4034 - Topics in Diplomacy Lab (3 credits)
Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4034

IS 4044 - International Communication (3 credits)
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required or instructor consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 4044

IS 4054 - Seminar in Global Political Economy (3 credits)
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4054

IS 4064 - Seminar in Global Development (3 credits)
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing worlds economic and political trajectories. Utilizes case studies, historical analysis and development economics to better understand the economic and political condition of countries in the developing world. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4064

IS 4074 - The Politics of Cybersecurity (3 credits)
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels.
Prerequisite(s): PSCI 3044 or IS 3044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4074

IS 4104 - Topics in European Studies (3 credits)
Selected issues pertaining to European Studies, such as racism in Europe, European art and society, religion and society in Europe, gender politics, and demographic trends in Europe. May be repeated twice with different content for a maximum of nine (9) credits. Pre: Senior Standing.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4104

IS 4114 - Topics in European Union Policies (3 credits)
Governmental and non-governmental actors in environmental policy, climate, energy, health, agricultural, education, industrial, social or similar policymaking. EU organizational structures and decision-making mechanisms. Public opinion. Analysis of policy results and effectiveness. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

IS 4124 - Topics in European Integration (3 credits)
Research and analysis of selected issues pertaining to European integration. Democracy and European governance. Nationalism and European integration. Impact of fascism and racism on European integration. Integration of refugees and migrants in European societies. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

IS 4134 - Capstone Research Project in European Studies (3 credits)
Independent research project focusing on contemporary Europe. Identifying a topic of inquiry, formulating a research question, conducting a literature review, and preparing a research proposal. Collecting, evaluating and analyzing data, composing a research paper and presenting the research findings. Topics may originate from any discipline contributing to European studies. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

IS 4144 - Topics in Transatlantic Relations (3 credits)
Research and analysis of selected post World War II political, diplomatic and security issues pertaining to transatlantic relations. Topics under examination include: US-EU relations and European security; the transatlantic partnership and world order; transatlantic politics and the global economic system; causes of the transatlantic divide; British foreign policy, transatlantic relations and European security. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4144

IS 4154 - Topics in Transatlantic Studies (3 credits)
Research and analysis of selected issues pertaining to transatlantic studies. Topics under examination include: religion and the transatlantic world; the political economy of the transatlantic slave trade; and the role of culture, language, and literature in cementing transatlantic ties. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: PSCI 4154

IS 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4174, PSCI 4174

IS 4184 - Capstone Project Transatlantic Studies (3 credits)
Independent research project focusing on issues and topics pertaining to transatlantic studies. Identifying a topic of inquiry, formulating a research question, conducting a literature review, and preparing a research proposal. Collecting, evaluating and analyzing data, composing a research paper and presenting the research findings. Topics may originate from any discipline contributing to transatlantic studies. Pre: Senior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4184

IS 4614 - Senior Seminar in International Relations (3 credits)
Selected topics in international relations, including objectives of national policy; dimensions and components of national power; comparative diplomacy; international conflict and cooperation; instruments of conflict resolution. Topics vary from semester to semester as announced. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3615 or PSCI 3616 or IS 3615 or IS 3616 or PSCI 3625 or PSCI 3626 or PSCI 3734 or IS 3626 or IS 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4614

IS 4714 - Senior Seminar in Policy Analysis (3 credits)
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3724 and PSCI 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4714

IS 4734 - Theories and Practices of International Conflict Management (3 credits)
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role of international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice.
Prerequisite(s): PSCI 3616 or IS 3616
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4734

IS 4735 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PSCI 4735

IS 4736 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PSCI 4736

IS 4744 - Intelligence Analysis Workshop (3 credits)
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4744

IS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

IS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

EUropean & Transatlantic Studies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required International Studies Courses		
IS 1034	Introduction to International Studies and Political Science	3
IS 2084	The Evolution of World Order	3
Select one of the following:		3
IS 3115	Selected World Problems	
IS 3116	Selected World Problems	
Required Foreign Language		
Select 12 credit hours at the 3000-4000 level. [2]		12
Subtotal		21
Requirements for the European & Transatlantic Studies (EUTS) Major		
IS 1004	Nations and Nationalities	3
IS 1024	Comp Gov & Politics	3
HIST 1026	Introduction to European History	3
IS 2004	Research and Writing in International Studies	3
HIST 2604	Introduction to Data in Social Context	3
Elective Courses for the EUTS Major		
Select one of the following:		33
Option 1 European Union & Transatlantic Relations		
Option 2 European History, Culture, & Thought		
Option 3 Transatlantic History, Culture, & Thought		
Option 4 General		
Subtotal		48
Free Electives [3]		
Select remaining credit hours to fulfill remaining credits required for graduation.		24
Subtotal		24
Pathways to General Education [4]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
IS 2004 (major requirement) may be utilized to satisfy Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		
Pathways Concept 2 - Critical Thinking in the Humanities		
HIST 1026 (major requirement) may be utilized to satisfy Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
IS 1004 (major requirement) may be utilized to satisfy Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		
IS 1024 (major requirement) may be utilized to satisfy Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) . (HIST 2604)		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [5]		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
IS 1004 (major requirement) may be utilized to satisfy Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		
Subtotal		27
Total Credits		**120**

1 Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses will be offered.

2 The following languages are suggested for students in the EUTS major: Arabic, French, German, Italian, Russian, and Spanish.
See undergraduate course catalog for current course offerings.
The following courses are only offered as Pass/Fail and **can be used** toward fulfillment of this requirement:

- ARBC 3124 Arabic for Oral Proficiency
- FR 3125 French for Oral Proficiency
- FR 3126 French for Oral Proficiency
- GER 3125 German Oral Proficiency
- GER 3126 German Oral Proficiency
- JPN 3125 Japanese for Oral Proficiency
- JPN 3126 Japanese for Oral Proficiency
- RUS 3124 Russian for Oral Proficiency
- SPAN 3125 Spanish for Oral Proficiency
- SPAN 3126 Spanish for Oral Proficiency

The following courses are **excluded** and cannot be used to fulfill this requirement:
If a student wishes to use an excluded course toward this requirement: Requests for exceptions must be made in writing to the Director of the International Studies Program and the student's assigned advisor. No more than one course exception will be granted.

- ARBC 3304 Modern Arabic Literature in Translation
- ARBC 3474 Topics in Arab Cinema
- CHN 3474 Topics in Chinese Cinema
- FR 3954 Study Abroad
- RUS 3304 Survey of Nineteenth-Century Russian Literature in Translation
- RUS 3314 Survey of Twentieth-Century Russian Literature in Translation

- RUS 3424 Topics in Russian Literature in English
- RUS 3434 The Works of Vladimir Nabokov

[3] IS 3116 Selected World Problems focuses exclusively on problems related to Europe. This course may be repeated for a maximum of nine (9) credit hours.

[4] For the EUTS majors you must complete the following requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu. **You must complete each requirement listed.**

[5] Prerequisites of MATH 1014 Precalculus with Transcendental Functions or higher may be required.

Options

Option 1 European Union & Transatlantic Relations

Code	Title	Credits
IS 1104	Introduction to European Studies	3
IS 1114	Introduction to Transatlantic Studies	3
IS 3804	European Integration	3
IS 3814	The European Union: Institutions and Policies	3
Select seven of the following: [1,2]		21
IS 2104	Europe Country Analysis	
IS 2224	Geography of Europe	
IS 2114	Transatlantic Political Frameworks	
IS 3116	Selected World Problems [3]	
PSCI 3515	European Political Systems	
PSCI 3516	European Political Systems	
PSCI 3524	Politics of Post-Communist Systems	
IS 3625	US-Russia Foreign Policies	
IS 3626	US-Russia Foreign Policies	
IS 3824	European Union's Foreign and Security Policy	
IS 3825	European Union's Foreign Relations	
IS 3826	European Union's Foreign Relations	
IS 3834	European Security Governance	
IS 3844	European Geopolitics	
IS 3854	European Political Economy	
IS 3874	The European Business Environment	
IS 3894	Transatlantic Relations Since 1945	
IS 3914	European Economics	
IS 3924	Theories of Transatlantic Relations	
IS 3934	NATO & European Security	
IS 3954	Study Abroad (var) [4]	
IS 4034	Topics in Diplomacy Lab [3,5]	
IS 4104	Topics in European Studies [3,5]	
IS 4114	Topics in European Union Policies [3]	
IS 4124	Topics in European Integration [3]	
IS 4134	Capstone Research Project in European Studies	
IS 4144	Topics in Transatlantic Relations [3]	
IS 4154	Topics in Transatlantic Studies	
IS 4184	Capstone Project Transatlantic Studies [5]	
IS 4736	Topics in Multilateral Diplomacy Workshop [3]	
IS 4964	Field Study (var) [6]	
IS 4974	Independent Study (var) [5]	
IS 4994	Undergraduate Research (var) [3,5]	
Total Credits		**33**

[1] Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses are offered.

[2] Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

[3] Students can take this course under different topic for up to nine credit hours.

[4] International Enrollment and Study Abroad courses should be relevant to the EUropean & Transatlantic Studies major. Please ask the International Studies advisor in advance whether the proposed courses qualify and receive the necessary approval.

[5] The content of the Independent Study, as well as the topic of the Diplomacy Lab project and Undergraduate Research should be relevant to the EUropean & Transatlantic Studies major. Please ask the International Studies advisor in advance whether the proposed Independent Study or Special Study or Undergraduate Research, topic qualifies.

[6] IS 4964 Field Study is only offered as Pass/Fail and can be used toward fulfillment of a major elective from the corresponding list.

Option 2 European History, Culture, & Thought

Code	Title	Credits
IS 1104	Introduction to European Studies	3
Select ten of the following: [1,2]		30
International Studies & Political Science		
PSCI 2014	Introduction to Political Theory	
PSCI 3015	Political Theory	
PSCI 3016	Political Theory	
IS 3884	Culture and Society in Contemporary Europe	
IS 3954	Study Abroad (var) [4]	
IS 4104	Topics in European Studies [3]	
IS 4134	Capstone Research Project in European Studies	
IS 4964	Field Study (var) [6]	
IS 4974	Independent Study (var) [5]	
IS 4994	Undergraduate Research (var) [3,5]	
Arabic (ARBC)		
ARBC 2774	Arab Culture and Civilization	
ARBC 3304	Modern Arabic Literature in Translation	
ARBC 3474	Topics in Arab Cinema	
ARBC 4334	Research in Arab Culture	
French (FR)		
FR 2714	Introduction to French Culture and Civilization	
FR 3205		
FR 3206		
FR 3304	Introduction to French Literature	
FR 3424	French Culture from Middle Ages to Renaissance	
FR 3434	French Culture from Baroque to Revolution	
FR 3444	French Culture from Romanticism to Belle Epoque	
FR 3454	French Culture from World Wars to Global Present	
FR 4314	Studies in French Literature	
FR 4324	Special Topics in French Life, Literature and Language	

German (GER)	
GER 2724	Introduction to German Culture and Civilization
GER 3204	Culture of the German-Speaking Countries
GER 3305	Topics in German Culture and Literature
GER 3306	Topics in German Culture and Literature
GER 3474	Topics in German Cinema
GER 4304	Age of Goethe
GER 4314	Studies in 19th-Century Literature
GER 4324	Studies in 20th-Century Literature
GER 4334	Special Topics in German Life, Literature, and Language
History (HIST)	
HIST 1025	Introduction to European History
HIST 2114	Topics and Critical Issues in European History
HIST 2184	History of the Balkans
HIST 3364	The Age of Revolution and Napoleon
HIST 3374	French Empire
HIST 3484	Nazi Germany: History and Memory
HIST 3524	
HIST 3534	Modern Military History
HIST 3564	The Cold War
HIST 3544	World War II
HIST 3614	Imperial Russia
HIST 3644	Twentieth-Century Russia
HIST 3684	
HIST 3394	
Italian (ITAL)	
ITAL 3305	Introduction to Italian Literature in Context
ITAL 3306	Introduction to Italian Literature in Context
ITAL 3474	Topics in Italian Cinema
Religion & Culture (RLCL)	
RLCL 1024	Judaism, Christianity, and Islam
RLCL 3014	Women and Gender in Islam
RLCL 3884	Culture and Society in Contemporary Europe
Russian (RUS)	
RUS 2734	Introduction to Russian Culture and Civilization
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation
RUS 3424	Topics in Russian Literature in English
RUS 4204	Topics in Russian Culture and Civilization
RUS 4304	Studies in Russian Literature
Sociology (SOC)	
SOC 3884	Culture and Society in Contemporary Europe
Spanish (SPAN)	
SPAN 2744	Topics in Spanish Culture
SPAN 3304	Introduction to Hispanic Literature
SPAN 3404	Early Peninsular Culture and Literature
SPAN 3414	Topics in Modern Cultures of Spain
SPAN 4114	Topics in Spanish Linguistics
SPAN 4124	Spanish Translation: Theory and Technique
SPAN 4304	Topics in Early Modern Literature and Culture
SPAN 4314	Studies in 18th and 19th Century Literature
SPAN 4324	Studies in 20th and 21st Century Hispanic Literature
SPAN 4334	Special Topics in Hispanic Life, Literature, and Language
SPAN 4344	Hispanic Literature and the Representation of History
Total Credits	**33**

1 Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses are offered.

2 Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

3 International Enrollment and Study Abroad courses should be relevant to the EUropean & Transatlantic Studies major. Please ask the International Studies advisor in advance whether the proposed courses qualify and receive the necessary approval.

4 Students can take this course under different topic for up to nine credit hours.

5 IS 4964 Field Study is only offered as Pass/Fail and can be used toward fulfillment of a major elective from the corresponding list.

6 The content of the Independent Study, as well as the topic of Undergraduate Research should be relevant to the EUropean & Transatlantic Studies major. Please ask the International Studies advisor in advance whether the proposed Independent Study or Special Study or Undergraduate Research, topic qualifies.

Option 3 Transatlantic History, Culture, & Thought

Code	Title	Credits
IS 1114	Introduction to Transatlantic Studies	3
Select ten of the following: [1,2]		30
International Studies & Political Science		
IS 2114	Transatlantic Political Frameworks	
IS 3894	Transatlantic Relations Since 1945	
IS 3924	Theories of Transatlantic Relations	
IS 3954	Study Abroad (var) [3]	
IS 4154	Topics in Transatlantic Studies [4]	
IS 4184	Capstone Project Transatlantic Studies	
IS 4964	Field Study (var) [3]	
IS 4994	Undergraduate Research (var) [3]	
History (HIST)		
HIST 1025	Introduction to European History	
HIST 1224	Mesoamerica and the Andes	
HIST 1515	History of Africa	
HIST 1516	History of Africa	
HIST 2114	Topics and Critical Issues in European History	
HIST 2275	African-American History	
HIST 2276	African-American History	
HIST 3004	Colonial America	
HIST 3014	The American Revolution	
HIST 3174	Native American History	
HIST 3374	French Empire	
HIST 3394		
HIST 3544	World War II	

HIST 3564	The Cold War
Spanish (SPAN)	
SPAN 2754	Topics in Spanish American Culture [4]
SPAN 2764	Introduction to Latino American Studies
SPAN 3304	Introduction to Hispanic Literature
SPAN 3444	Topics in Early Spanish American Cultures
SPAN 3464	Topics in Modern Mexican and Central American Cultures
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures
SPAN 3484	Topics in Modern Andean and Southern Cone Cultures
SPAN 4334	Special Topics in Hispanic Life, Literature, and Language [4]
SPAN 4344	Hispanic Literature and the Representation of History
Total Credits	**33**

[1] Please note that not all courses are offered each semester. Check in the Undergraduate Course Catalog or with the department offering the course to find out when courses are offered.

[2] Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

[3] Students can take this course under different topic for up to nine credit hours.

[4] International Enrollment and Study Abroad courses should be relevant to the EUropean & Transatlantic Studies major. Please ask the International Studies advisor in advance whether the proposed courses qualify and receive the necessary approval.

Option 4 General

Code	Title	Credits
IS 1104	Introduction to European Studies	3
IS 1114	Introduction to Transatlantic Studies	3
IS 3804	European Integration	3
IS 3814	The European Union: Institutions and Policies	3
Select seven courses from any of the elective lists in Options 1, 2, or 3		21
Total Credits		**33**

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete IS 1004 Nations and Nationalities , IS 1034 Introduction to International Studies and Political Science , IS 2004 Research and Writing in International Studies , IS 2054 Introduction to World Politics, IS 2064 The Global Economy and World Politics, IS 2084 The Evolution of World Order and Foreign Language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with an International Studies degree of which there are sixty-nine (69) required hours for the Major in EUropean & Transatlantic Studies (EUTS).

In-major GPA

All of the courses in the core and major requirements and major electives are included in the in-major GPA calculation. A GPA of 2.0 or above both overall and in-major GPA is required for graduation.

Prerequisites

Some courses listed may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Dual Use of Courses

In accordance with the State Council guidelines, courses used to fulfill the SCHEV approved degree core may not also be used to meet The Pathways to General Education or major requirements.

Intra-departmental Majoring and Minoring

Due to overlapping of courses, students cannot pursue another major within the Department of Political Science. However, they can pursue any of the minors offered by the department except the Minor in Political Science.

Foreign Language Requirement

University and Admissions Foreign Language Requirement (No Credits Count Toward the Degree)

This is a requirement that is separate from the International Studies requirement. *Completion of this requirement* ***will not*** *fulfill your International Studies Language Requirement.*

- Students who completed three years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete three years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete two years of a single foreign, classical, or sign language in high school plus 1106 or the equivalent in college (these three hours of 1106 do count toward the 120 required for graduation and calculates into the GPA)

    or
  - Complete an 1105-1106 foreign language (e.g. FR, GR, SPAN) grouping or the equivalent in college (these six hours do **not** count toward the 120 required for graduation).
  -

International Relations Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required International Studies Courses		
IS 1034	Introduction to International Studies and Political Science	3
IS 2084	The Evolution of World Order	3
Select one of the following:		3
IS 3115	Selected World Problems	
IS 3116	Selected World Problems	
Required Foreign Language		
Select 12 credits of a single foreign language at the 3000-4000 level [1]		12

The following courses are only offered as Pass/Fail and **can be used** toward fulfillment of this requirement:		
ARBC 3124	Arabic for Oral Proficiency	
FR 3125	French for Oral Proficiency	
FR 3126	French for Oral Proficiency	
GER 3125	German Oral Proficiency	
GER 3126	German Oral Proficiency	
JPN 3125	Japanese for Oral Proficiency	
JPN 3126	Japanese for Oral Proficiency	
RUS 3124	Russian for Oral Proficiency	
SPAN 3125	Spanish for Oral Proficiency	
SPAN 3126	Spanish for Oral Proficiency	
The following courses are **excluded** and cannot be used to fulfill this requirement:		
ARBC 3304	Modern Arabic Literature in Translation	
ARBC 3474	Topics in Arab Cinema	
CHN 3474	Topics in Chinese Cinema	
FR 3954	Study Abroad	
GER 3474	Topics in German Cinema	
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation	
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation	
RUS 3424	Topics in Russian Literature in English	
RUS 3434	The Works of Vladimir Nabokov	
Subtotal		21
Major Requirements		
Major Courses		
IS 1004	Nations and Nationalities	3
IS 2004	Research and Writing in International Studies	3
IS 2054	Introduction to World Politics	3
IS 2064	The Global Economy and World Politics	3
IS 3615	International Relations [2]	3
IS 3616	International Relations [2]	3
Select one of the following:		3
IS 4034	Topics in Diplomacy Lab [2]	
PSCI 4514	Senior Seminar in Comparative Politics [2]	
IS 4614	Senior Seminar in International Relations [2]	
PSCI 4724	Senior Seminar in Political Theory [2]	
IS 4734	Theories and Practices of International Conflict Management [2]	
Elective Courses For The Major		
Select 15 credit hours from the list below [3]		15
Select remaining credit hours of Free Electives to fulfill remaining credits required for graduation.		18
Subtotal		54
III. Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
IS 2004	Research and Writing in International Studies (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
IS 2054	Introduction to World Politics (major requirement)	3
IS 2064	The Global Economy and World Politics (major requirement)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [4]		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
IS 1004	Nations and Nationalities (major requirement)	3
Subtotal		45
Total Credits		**120**

1. See undergraduate course catalog for current course offerings.
2. Prerequisites: Some courses listed on this checksheet have prerequisites; please consult the University Catalog and/or check with your advisor.
3. IREL major courses selected will not double count toward IREL major electives
4. Prerequisites of MATH 1014 Precalculus with Transcendental Functions or higher may be required.

Elective Courses for the Major [1]

IREL major courses selected will not double count toward IREL major electives.

Code	Title	Credits
Political Science (PSCI)		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 2014	Introduction to Political Theory	3
PSCI 2024	Research Methods in Political Science	3
PSCI 3015	Political Theory	3
PSCI 3016	Political Theory	3
PSCI 3255	The Politics of Race, Ethnicity and Gender [2]	3
PSCI 3256	The Politics of Race, Ethnicity and Gender [2]	3
PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
PSCI 3514	Latin American Government and Politics [2]	3
PSCI 3515	European Political Systems [2]	3
PSCI 3516	European Political Systems [2]	3
PSCI 3524	Politics of Post-Communist Systems [2]	3
PSCI 3534	African Government and Politics [2]	3

PSCI 3544	The State of Israel: A Political History [2]	3
PSCI 3564	Violent Political Change [2]	3
PSCI 3574	Government and Politics of Japan [2]	3
PSCI 3584	Governments and Politics of Asia [2]	3
PSCI 3684	Indigenous Peoples and World Politics [2]	3
PSCI 3764	Contemporary Democratic Theory [2]	3
PSCI 3774	Marxian Political Analysis [2]	3
PSCI 3784	Origins of the State [2]	3
PSCI 4514	Senior Seminar in Comparative Politics [2]	3
PSCI 4724	Senior Seminar in Political Theory [2]	3
International Studies (IS)		
IS 1024	Comp Gov & Politics	3
IS 1114	Introduction to Transatlantic Studies	3
IS 2114	Transatlantic Political Frameworks	3
IS 3104	Security Studies: Theories and Concepts [2]	3
IS 3175	Global Development [2]	3
IS 3176	Global Development [2]	3
IS 3184	Human Security [2]	3
IS 3554	Comparative Political Economy [2]	3
IS 3594	Topics in Middle East Politics and International Relations [2]	3
IS 3624	Foreign Policy and Diplomacy [2]	3
IS 3814	The European Union: Institutions and Policies [2]	3
IS 3824	European Union's Foreign and Security Policy [2]	3
IS 3924	Theories of Transatlantic Relations [2]	3
IS 4054	Seminar in Global Political Economy [2]	3
IS 4064	Seminar in Global Development [2]	3
IS 4104	Topics in European Studies [2]	3
IS 4114	Topics in European Union Policies [2]	3
IS 4124	Topics in European Integration [2]	3
IS 4144	Topics in Transatlantic Relations [2]	3
IS 4154	Topics in Transatlantic Studies [2]	3
IS 4184	Capstone Project Transatlantic Studies [2]	3
IS 4134	Capstone Research Project in European Studies [2]	3
IS 4614	Senior Seminar in International Relations [2]	3
IS 4734	Theories and Practices of International Conflict Management [2]	3
IS 4735	Topics in Multilateral Diplomacy Workshop [2]	3
IS 4736	Topics in Multilateral Diplomacy Workshop [2]	3
IS 4964	Field Study [3]	1-19
International Studies (IS)		
A maximum of six credits from the following can be used toward the 15 credits of required IREL electives:		
IS 2034	Geography of Global Conflict	3
IS 2044	Food, War and Conflict	3
IS 2104	Europe Country Analysis	3
IS 2474	Religion and Violence	3
IS 3004	Professionalism and Careers in Political Science and International Studies [2]	3
IS 3114	Global Security [2]	3
IS 3134	Global Conflict and War [2]	3
IS 3144	Global Governance and Public Policy [2]	3
IS 3154	Topics in Global Public Policies [2]	3
IS 3164	Global Trade: Structures and Policies [2]	3
IS 3174	Monetary Foundations of the World Economy [2]	3
IS 3194	Nuclear Strategy & Politics [2]	3
IS 3374	The Politics of Energy [2]	3
IS 3625	US-Russia Foreign Policies [2]	3
IS 3626	US-Russia Foreign Policies [2]	3
IS 3634	Human Rights: Global Issues [2]	3
IS 3704	National Security Strategy [2]	3
IS 3734	National Security [2]	3
IS 3735	[2]	3
IS 3736	[2]	3
IS 3795	Global Terrorism and Counterterrorism [2]	3
IS 3796	Global Terrorism and Counterterrorism [2]	3
IS 3804	European Integration [2]	3
IS 3854	European Political Economy [2]	3
IS 3914	European Economics [2]	3
IS 3894	Transatlantic Relations Since 1945 [2]	3
IS 3934	NATO & European Security [2]	3
IS 3944	International Enrollment	0
IS 3954	Study Abroad	1-19
IS 4014	International Development [2]	3
IS 4024	Seminar in Diplomacy and Security [2]	3
IS 4034	Topics in Diplomacy Lab [2]	2
IS 4044	International Communication [2]	3
IS 4974	Independent Study [4]	1-19
IS 4984	Special Study [4]	1-19
IS 4994	Undergraduate Research [4]	1-19

[1] Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

[2] Indicates the course has a pre-requisite. Please consult the University Catalog and/or check with your advisor.

[3] IS 4964 Field Study is only offered as Pass/Fail and can be used toward fulfillment of a major elective from the corresponding list.

[4] The content of the Independent Study or Special Study, as well as the topic of Undergraduate Research should be relevant to the International Relations major. Please ask the International Studies advisor in advance whether the proposed Independent Study or Special Study or Undergraduate Research, topic qualifies.

Satisfactory Progress: To proceed satisfactorily toward a degree, a student must complete IS 1004 Nations and Nationalities , IS 1034 Introduction to International Studies and Political Science, IS 2004 Research and Writing in International Studies , IS 2054 Introduction to World Politics , IS 2064 The Global Economy and World Politics , IS 2084 The Evolution of World Order , and Foreign language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement: A total of 120 hours is required to graduate with an International Studies degree of which there are fifty-seven (57) required hours for the International Relations major.

In-major GPA: All of the courses in the core and major requirements and major electives are included in the in-major GPA calculation. A GPA of 2.0 or above both overall and in-major GPA is required for graduation.

Dual Use of Courses: No course can double count within or between International Studies Program-related majors or minors with the exception of the Core Degree Requirements and IS 1004 Nations and Nationalities , IS 2004 Research and Writing in International Studies , IS 2054 Introduction to World Politics and IS 2064 The Global Economy and World Politics . In accordance with the State Council guidelines, courses used to fulfill the SCHEV approved degree core may not also be used to meet Pathways General Education or major requirements.

Intra-departmental majoring and minoring: Due to overlapping of courses, students pursuing one or more majors associated with the International Studies Program cannot major or minor in Political Science.

Intra-IS Program majoring and minoring: Students may pursue more than one major or minor associated with the International Studies Program. In this case, the policy pertaining to the "Dual Use of Courses" will apply.

Prerequisites: Some courses listed have prerequisites; please consult the University Catalog and/or check with your advisor.

Pathways to General Education: More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu.

Foreign Language Requirements

University and Admissions Foreign Language Requirement

*This is a requirement that is **separate** from the International Studies requirement. Completion of this requirement **will not** fulfill your International Studies Language Requirement.*

- Students who completed three years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete three years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete two years of a single foreign, classical, or sign language in high school plus 1106 or the equivalent in college {these three hours of 1106 do count toward the 120 required for graduation and calculates into the GPA)

    or
  - Complete an 1105-1106 foreign language (e.g. FR, GR, SPAN) grouping or the equivalent in college {these six hours do NOT count toward the 120 required for graduation).

International Studies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required International Studies Courses		
IS 1034	Introduction to International Studies and Political Science	3
IS 2084	The Evolution of World Order	3
Select one of the following:		3
IS 3115	Selected World Problems	
IS 3116	Selected World Problems	
Subtotal		9
Required Foreign Language		
Select 12 credits of a single foreign language at the 3000-4000 level [1]		12
Subtotal		12
Major Requirements		
IS 1004	Nations and Nationalities	3
IS 2004	Research and Writing in International Studies	3
IS 2054	Introduction to World Politics	3
IS 2064	The Global Economy and World Politics	3
Select one of the following:		3
IS 3114	Global Security	
IS 3184	Human Security	
IS 3615	International Relations	
IS 4044	International Communication (Senior Standing in IS and instructor consent required)	
Select one of the following:		3
IS 3164	Global Trade: Structures and Policies	
IS 3174	Monetary Foundations of the World Economy	
IS 3175	Global Development	
IS 3176	Global Development	
Select one of the following:		3
IS 4004	Seminar in International Studies (Senior Standing in IS and instructor consent required)	
IS 4014	International Development	
IS 4034	Topics in Diplomacy Lab	
IS 4054	Seminar in Global Political Economy	
IS 4064	Seminar in Global Development	
Subtotal		21
Elective Courses		
Select 15 hours of elective courses (see below): [2,3,4,5]		15
Select remaining credit hours of Free Electives to fulfill remaining credits required for graduation.		18
Subtotal		33
Pathways to General Education [6]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
IS 2004	Research and Writing in International Studies (1A ; major requirement)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
IS 2054	Introduction to World Politics (major requirement)	3
IS 2064	The Global Economy and World Politics (major requirement)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [7]		3

Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
IS 1004	Nations and Nationalities (major requirement)	3
Subtotal		45
Total Credits		**120**

1 See undergraduate course catalog for current course offerings. The following courses are only offered as Pass/Fail and **can be used** toward fulfillment of this requirement:

- ARBC 3124 Arabic for Oral Proficiency
- FR 3125 French for Oral Proficiency
- FR 3126 French for Oral Proficiency
- GER 3125 German Oral Proficiency
- GER 3126 German Oral Proficiency
- JPN 3125 Japanese for Oral Proficiency
- JPN 3126 Japanese for Oral Proficiency
- RUS 3124 Russian for Oral Proficiency
- SPAN 3125 Spanish for Oral Proficiency
- SPAN 3126 Spanish for Oral Proficiency

The following courses are **excluded** and cannot be used to fulfill this requirement:
If a student wishes to use an excluded course toward this requirement: Requests for exceptions must be made in writing to the Director of the International Studies Program and the student's assigned advisor. No more than one course exception will be granted.

- ARBC 3304 Modern Arabic Literature in Translation
- ARBC 3474 Topics in Arab Cinema
- CHN 3474 Topics in Chinese Cinema
- FR 3954 Study Abroad
- GER 3474 Topics in German Cinema
- RUS 3304 Survey of Nineteenth-Century Russian Literature in Translation
- RUS 3314 Survey of Twentieth-Century Russian Literature in Translation
- RUS 3424 Topics in Russian Literature in English
- RUS 3434 The Works of Vladimir Nabokov

2
- At least 6 hours at the 3000 and/or 4000 level. Elective courses must be **either** in a second foreign language **or** from the courses listed below.
- Other courses with an international character and/or relevance may also be considered. These courses will be evaluated by the International Studies Program advisor.
- IS major courses selected will not double count toward IS major electives.

3 Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses are offered.

4 Check the Undergraduate Course Catalog or the Timetable of classes for the most up to date course restrictions and pre-requisites.

5 The content of the Independent Study or Special Study, as well as the topic of Undergraduate Research should be relevant to the International Relations major. Please ask the International Studies advisor in advance whether the proposed Independent Study or Special Study or Undergraduate Research, topic qualifies.

6 For the IPPL, IREL, IS, or NSFA majors you must complete the following requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu.
You must complete each requirement listed.

7 Prerequisites of MATH 1014 Precalculus with Transcendental Functions or higher may be required.

Elective Courses

Africana Studies (AFST)

Code	Title	Credits
AFST 1814	Introduction to African Studies	3
AFST 2144	African Religions	3
AFST 2204	Race and Gender in Religion and Culture	3
AFST 2454	Race and Racism	3

Agricultural and Applied Economics (AAEC)

Code	Title	Credits
AAEC 1005	Economics of the Food and Fiber System	3
AAEC 1006	Economics of the Food and Fiber System	3
AAEC 1264		3
AAEC 3024	Monetary and Global Issues in Applied Economics	3
AAEC 3204	International Agricultural Development and Trade	3
AAEC 3324	Environment and Sustainable Development Economics	3
AAEC 4135	International Economics	3
AAEC 4204	Food and Agricultural Policy	3
AAEC 4324	Rural and Regional Development Policy	3
AAEC 4344	Sustainable Development Economics	3
AAEC 4464	Water Resources Policy and Economics	3

American Indian Studies (AINS)

Code	Title	Credits
AINS 2104	Oral Traditions and Culture	3
AINS 3684	Indigenous Peoples and World Politics	3

Arabic (ARBC)

Code	Title	Credits
ARBC 2774	Arab Culture and Civilization	3
ARBC 3304	Modern Arabic Literature in Translation	3

Communication (COMM)

Code	Title	Credits
COMM 2084	Media and Society	3

Economics (ECON)

Code	Title	Credits
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3

ECON 3004	Contemporary Economic Issues	3
ECON 3024	Economic Justice	3
ECON 3214	Money and Banking	3
ECON 3914	European Economics	3
ECON 4124	Growth and Development	3
ECON 4135	International Economics	3
ECON 4136	International Economics	3
ECON 4144	Economics of China	3

French (FR)

Code	Title	Credits
FR 2714	Introduction to French Culture and Civilization	3
FR 3205		3
FR 3206		3
FR 3304	Introduction to French Literature	3
FR 3306		3
FR 3314	Introduction to Francophone Studies	3
FR 4314	Studies in French Literature	3
FR 4324	Special Topics in French Life, Literature and Language	3

Geography (GEOG)

Code	Title	Credits
GEOG 1004	Introduction to Human Geography	3
GEOG 1014	World Regions	3
GEOG 1115	Seeking Sustainability	3
GEOG 1116	Seeking Sustainability	3
GEOG 2004	Water, Environment, and Society	3
GEOG 2034	Geography of Global Conflict	3
GEOG 2134	Geography of the Global Economy	3
GEOG 3034	The CIA: Its Capabilities in Todays Geo-Political World	3
GEOG 3104	Environmental Justice, Resources and Development	3
GEOG 3254	Geography of East Asia	3
GEOG 3274	Polar Environments	3
GEOG 4054	Geography of Wine	3
GEOG 4074	Medical Geography of Infectious Diseases	3
GEOG 4204	Geography of Resources	3
GEOG 4214	Gender, Environment, and International Development	3
GEOG 4764	International Development Policy and Planning	3

German (GER)

Code	Title	Credits
GER 2724	Introduction to German Culture and Civilization	3
GER 3204	Culture of the German-Speaking Countries	3
GER 3305	Topics in German Culture and Literature	3
GER 3306	Topics in German Culture and Literature	3
GER 3474	Topics in German Cinema	3
GER 4304	Age of Goethe	3
GER 4314	Studies in 19th-Century Literature	3
GER 4324	Studies in 20th-Century Literature	3
GER 4334	Special Topics in German Life, Literature, and Language	3

History (HIST)

Code	Title	Credits
HIST 1025	Introduction to European History	3
HIST 1026	Introduction to European History	3
HIST 1214	History of the Modern World	3
HIST 1215	Intro to World History	3
HIST 1216	Intro to World History	3
HIST 1224	Mesoamerica and the Andes	3
HIST 1354	Conflict and Security in Modern East Asia	3
HIST 1515	History of Africa	3
HIST 1516	History of Africa	3
HIST 2124	Topics and Critical Issues in World History	3
HIST 2165		3
HIST 2166	History of France	3
HIST 2184	History of the Balkans	3
HIST 2345	History of the Middle East	3
HIST 2346	History of the Middle East	3
HIST 2355	History of China	3
HIST 2356	History of Modern China	3
HIST 2364	History of Japan	3
HIST 3254	The Vietnam War	3
HIST 3324	The Medieval World	3
HIST 3334	The Renaissance World, 1350-1500	3
HIST 3344	Early Modern and Reformation History, 1500-1650	3
HIST 3364	The Age of Revolution and Napoleon	3
HIST 3394		3
HIST 3484	Nazi Germany: History and Memory	3
HIST 3494	The Holocaust	3
HIST 3504	The Age of The Crusades	3
HIST 3524		3
HIST 3534	Modern Military History	3
HIST 3544	World War II	3
HIST 3554	Age of Globalization	3
HIST 3594	The Rise of Modern Latin America	3
HIST 3614	Imperial Russia	3
HIST 3624	Health and Illness in African History	3
HIST 3644	Twentieth-Century Russia	3
HIST 3654	Arab-Israeli Conflict	3
HIST 3664	Revolutionary China	3
HIST 3674	Topics in Chinese History	3
HIST 3684		3
HIST 4004	Topics in Social and Cultural History	3

Humanities (HUM)

Code	Title	Credits
HUM 1324	Introductory Humanities: The Modern World	3
HUM 2104	Oral Traditions and Culture	3
HUM 3204	Multicultural Communication	3

International Studies (IS)

Code	Title	Credits
IS 1024	Comp Gov & Politics	3
IS 1114	Introduction to Transatlantic Studies	3
IS 1104	Introduction to European Studies	3
IS 2034	Geography of Global Conflict	3
IS 2044	Food, War and Conflict	3
IS 2104	Europe Country Analysis	3
IS 3004	Professionalism and Careers in Political Science and International Studies	3
IS 3064	Food Politics	3
IS 3144	Global Governance and Public Policy	3
IS 3154	Topics in Global Public Policies	3
IS 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
IS 3374	The Politics of Energy	3
IS 3384	Politics of Global and Comparative Migration	3
IS 3394	Comparative Politics of Immigrant Inclusion	3
IS 3514	Latin American Government and Politics	3
IS 3515	European Political Systems	3
IS 3516	European Political Systems	3
IS 3524	Politics of Post-Communist Systems	3
IS 3534	African Government and Politics	3
IS 3574	Government and Politics of Japan	3
IS 3584	Governments and Politics of Asia	3
IS 3594	Topics in Middle East Politics and International Relations	3
IS 3624	Foreign Policy and Diplomacy	3
IS 3634	Human Rights: Global Issues	3
IS 3804	European Integration	3
IS 3814	The European Union: Institutions and Policies	3
IS 3864		3
IS 3894	Transatlantic Relations Since 1945	3
IS 4034	Topics in Diplomacy Lab	3
IS 4964	Field Study [1]	1-19

[1] **Prerequisites:** Some courses listed on this checksheet have prerequisites; please consult the University Catalog and/or check with your advisor.

[2] IS 4964 Field Study is only offered as Pass/Fail and **can be used** toward fulfillment of a major elective from the corresponding list.

Italian (ITAL)

Code	Title	Credits
ITAL 3305	Introduction to Italian Literature in Context	3
ITAL 3306	Introduction to Italian Literature in Context	3
ITAL 3474	Topics in Italian Cinema	3

Journalism and Mass Communication (JMC)

Code	Title	Credits
JMC 4044	International Communication	3

Judaic Studies (JUD)

Code	Title	Credits
JUD 2134	Judaism: A Survey of History, Culture, and Heritage	3
JUD 3494	The Holocaust	3
JUD 3544	The State of Israel: A Political History	3
JUD 4424	Advanced Topics in Jewish Culture, History and Thought	3

Management (MGT)

Code	Title	Credits
MGT 3874	The European Business Environment	3

Peace Studies and Violence Prevention (PSVP)

Code	Title	Credits
PSVP 2044	Peace and Violence	3
PSVP 4104	Global Society, Violence and the Prospects for Peace	3

Political Science (PSCI)

Code	Title	Credits
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 2014	Introduction to Political Theory	3
PSCI 3244	Political Communication	3
PSCI 3255	The Politics of Race, Ethnicity and Gender	3
PSCI 3256	The Politics of Race, Ethnicity and Gender	3
PSCI 3634	Human Rights: Global Issues	3
PSCI 3684	Indigenous Peoples and World Politics	3
PSCI 3764	Contemporary Democratic Theory	3
PSCI 3774	Marxian Political Analysis	3
PSCI 3784	Origins of the State	3
PSCI 4034	Topics in Diplomacy Lab	3

Religion and Culture (RLCL)

Code	Title	Credits
RLCL 1004	Introduction to Religion and Culture	3
RLCL 1024	Judaism, Christianity, and Islam	3
RLCL 1034	Religion and the Modern World	3
RLCL 1044	Religious Ethics	3
RLCL 1214	The Medieval World	3
RLCL 1904	Religion and Culture In Asia	3
RLCL 2004	Case Studies in Religion and Culture	3
RLCL 2054	Ethnography: Studying Culture	3
RLCL 2134	Judaism: A Survey of History, Culture, and Heritage	3
RLCL 2144	African Religions	3
RLCL 2204	Race and Gender in Religion and Culture	3
RLCL 2324	Islam	3
RLCL 2474	Religion and Violence	3
RLCL 3014	Women and Gender in Islam	3
RLCL 3204	Multicultural Communication	3
RLCL 3214	Religion and Culture in India	3
RLCL 3224	Religion and Culture in China and Japan	3
RLCL 3494	The Holocaust	3

RLCL 3504	The Age of The Crusades	3
RLCL 3544	The State of Israel: A Political History	3
RLCL 3604		3
RLCL 3884	Culture and Society in Contemporary Europe	3
RLCL 4024	Sociology of Religion	3
RLCL 4324	Topics in Religion and Culture	3

Russian (RUS)

Code	Title	Credits
RUS 2734	Introduction to Russian Culture and Civilization	3
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation	3
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation	3
RUS 3424	Topics in Russian Literature in English	3
RUS 4204	Topics in Russian Culture and Civilization	3
RUS 4304	Studies in Russian Literature	3

Sociology (SOC)

Code	Title	Credits
SOC 1004	Introductory Sociology	3
SOC 1014	Introduction to Social Anthropology	3
SOC 2004	Social Problems	3
SOC 2034	Diversity and Community Engagement	3
SOC 2054	Ethnography: Studying Culture	3
SOC 2454	Race and Racism	3
SOC 3004	Social Inequality	3
SOC 3014	Gender Relations	3
SOC 3314	Social Movements	3
SOC 3504	Population Trends and Issues	3
SOC 3884	Culture and Society in Contemporary Europe	3
SOC 4024	Sociology of Religion	3
SOC 4044	Military Sociology	3
SOC 4124	Topics in Culture	3
SOC 4764	International Development Policy and Planning	3

Spanish (SPAN)

Code	Title	Credits
SPAN 2744	Topics in Spanish Culture	3
SPAN 2754	Topics in Spanish American Culture	3
SPAN 2764	Introduction to Latino American Studies	3
SPAN 2774	Minority Languages in the Spanish-Speaking Context	3
SPAN 3304	Introduction to Hispanic Literature	3
SPAN 3404	Early Peninsular Culture and Literature	3
SPAN 3414	Topics in Modern Cultures of Spain	3
SPAN 3444	Topics in Early Spanish American Cultures	3
SPAN 3464	Topics in Modern Mexican and Central American Cultures	3
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures	3
SPAN 3484	Topics in Modern Andean and Southern Cone Cultures	3
SPAN 4304	Topics in Early Modern Literature and Culture	3
SPAN 4314	Studies in 18th and 19th Century Literature	3
SPAN 4324	Studies in 20th and 21st Century Hispanic Literature	3
SPAN 4334	Special Topics in Hispanic Life, Literature, and Language	3
SPAN 4344	Hispanic Literature and the Representation of History	3

Urban Affairs and Planning (UAP)

Code	Title	Credits
UAP 1024	Leadership, Service, and Public Problem Solving	3
UAP 2014		3
UAP 3014	Urban Policy and Planning	3
UAP 3224	Policy Implementation	3
UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 3744	Public Policy Analysis	3
UAP 3774	Marxian Political Analysis	3
UAP 4184	Community Involvement	3
UAP 4214	Gender, Environment, and International Development	3
UAP 4264	Environmental Ethics and Policy	3
UAP 4764	International Development Policy and Planning	3

Women & Gender Studies (WGS)

Code	Title	Credits
WGS 2204	Race and Gender in Religion and Culture	3
WGS 3014	Women and Gender in Islam	3
WGS 3214	Global Feminisms	3
WGS 4214	Gender, Environment, and International Development	3

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete IS 1004 Nations and Nationalities , IS 1034 Introduction to International Studies and Political Science , IS 2004 Research and Writing in International Studies , IS 2054 Introduction to World Politics , IS 2064 The Global Economy and World Politics , IS 2084 The Evolution of World Order , and foreign language 2105 & 2106 grouping by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with an International Studies degree of which there are fifty-seven (57) required hours for the International Studies major.

In-Major GPA

All of the courses in core and major requirements and major electives are included in the in-major GPA calculation. A GPA of 2.0 or above both overall and in-major GPA is required for graduation.

Dual Use of Courses

In accordance with the State Council guidelines, courses used to fulfill the SCHEV approved degree core (Core Degree Requirements) may

not also be used to meet The Pathways to General Education or major requirements.

Intra-Departmental Majoring and Minoring

Due to overlapping of courses, students cannot pursue another major within the Department of Political Science. However, they can pursue any of the minors offered by the department except the Minor in Political Science.

Prerequisites

Some courses listed have prerequisites; please consult the University Catalog and/or check with your advisor.

Foreign Language Requirement

University and Admissions Foreign Language Requirement (No Credits Count Toward the Degree)

*This is a requirement that is **separate** from the International Studies requirement.*
Completion of this requirement **will not** *fulfill your International Studies Language Requirement.*

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete 3 years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete 2 years of a single foreign, classical, or sign language in high school plus complete an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college (the 3 hours of 1106 do count toward the 120 required for graduation and calculates into the GPA)
    or
  - Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these 6 hours do **not** count toward the 120 required for graduation).
  -

National Security & Foreign Affairs Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required International Studies Courses		
IS 1034	Introduction to International Studies and Political Science	3
IS 2084	The Evolution of World Order	3
Select one of the following:		3
IS 3115	Selected World Problems	
IS 3116	Selected World Problems	
Required Foreign Language		
Select 12 credits from a single foreign language at the 3000-4000 level. [1]		12
The following courses are only offered as Pass/Fail and **can be used** toward fulfillment of this requirement:		
ARBC 3124	Arabic for Oral Proficiency	
FR 3125	French for Oral Proficiency	
FR 3126	French for Oral Proficiency	
GER 3125	German Oral Proficiency	
GER 3126	German Oral Proficiency	
JPN 3125	Japanese for Oral Proficiency	
JPN 3126	Japanese for Oral Proficiency	
RUS 3124	Russian for Oral Proficiency	
SPAN 3125	Spanish for Oral Proficiency	
SPAN 3126	Spanish for Oral Proficiency	
The following courses are **excluded** and cannot be used to fulfill this requirement:		
ARBC 3304	Modern Arabic Literature in Translation	
ARBC 3474	Topics in Arab Cinema	
CHN 3474	Topics in Chinese Cinema	
FR 3954	Study Abroad	
GER 3474	Topics in German Cinema	
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation	
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation	
RUS 3424	Topics in Russian Literature in English	
RUS 3434	The Works of Vladimir Nabokov	
Subtotal		21
Major Requirements		
NSFA Major Courses		
IS 1004	Nations and Nationalities	3
IS 2004	Research and Writing in International Studies	3
IS 2054	Introduction to World Politics	3
IS 2064	The Global Economy and World Politics	3
Select one of the following:		3
IS 3104	Security Studies: Theories and Concepts [2]	
IS 3615	International Relations [2]	
Select one of the following:		3
IS 3734	National Security [2]	
IS 3624	Foreign Policy and Diplomacy [2]	
Select one of the following:		3
IS 4024	Seminar in Diplomacy and Security [2]	
IS 4034	Topics in Diplomacy Lab [2]	
IS 4074	The Politics of Cybersecurity [2]	
IS 4734	Theories and Practices of International Conflict Management [2]	
IS 4735	Topics in Multilateral Diplomacy Workshop [2]	
IS 4736	Topics in Multilateral Diplomacy Workshop [2]	
IS 4744	Intelligence Analysis Workshop [2]	
Subtotal		21
Elective Courses		
Select 15 credit hours of NSFA major courses. Courses selected will not double count toward NSFA major electives. [3,4]		15
International Studies (IS):		
IS 1024	Comp Gov & Politics	
IS 2034	Geography of Global Conflict	
IS 2104	Europe Country Analysis	
IS 2224	Geography of Europe	

IS 3034	The CIA: Its Capabilities in Todays Geo-Political World	
IS 3044	The Politics of Internet Governance [2]	
IS 3054	The Dark Web and Threat Analytics [2]	
IS 3104	Security Studies: Theories and Concepts [2]	
IS 3114	Global Security [2]	
IS 3126	Intelligence and National Security [2]	
IS 3125	Intelligence and National Security [2]	
IS 3134	Global Conflict and War [2]	
IS 3135	Strategies of Modern Warfare [2]	
IS 3136	Strategies of Modern Warfare [2]	
IS 3194	Nuclear Strategy & Politics [2]	
IS 3615	International Relations	
IS 3616	International Relations	
IS 3624	Foreign Policy and Diplomacy [2]	
IS 3625	US-Russia Foreign Policies [2]	
IS 3626	US-Russia Foreign Policies [2]	
IS 3704	National Security Strategy [2]	
IS 3734	National Security [2]	
IS 3735	[2]	
IS 3736	[2]	
IS 3795	Global Terrorism and Counterterrorism	
IS 3796	Global Terrorism and Counterterrorism	
IS 3804	European Integration	
IS 3814	The European Union: Institutions and Policies	
IS 3824	European Union's Foreign and Security Policy [2]	
IS 3825	European Union's Foreign Relations [2]	
IS 3826	European Union's Foreign Relations [2]	
IS 3834	European Security Governance [2]	
IS 3844	European Geopolitics	
IS 3934	NATO & European Security	
IS 4024	Seminar in Diplomacy and Security [2]	
IS 4034	Topics in Diplomacy Lab [2]	
IS 4134	Capstone Research Project in European Studies	
IS 4735	Topics in Multilateral Diplomacy Workshop [2]	
IS 4736	Topics in Multilateral Diplomacy Workshop [2]	
IS 4744	Intelligence Analysis Workshop [2]	
IS 4964	Field Study [5]	
A maximum of 6 credits from the following can be used toward the 15 credits of required NSFA electives: [3,4]		
International Studies (IS):		
IS 1114	Introduction to Transatlantic Studies	
IS 2044	Food, War and Conflict	
IS 2114	Transatlantic Political Frameworks	
IS 2134	Geography of the Global Economy	
IS 2474	Religion and Violence	
IS 3004	Professionalism and Careers in Political Science and International Studies [2]	
IS 3144	Global Governance and Public Policy [2]	
IS 3154	Topics in Global Public Policies [2]	
IS 3164	Global Trade: Structures and Policies [2]	
IS 3174	Monetary Foundations of the World Economy [2]	
IS 3175	Global Development [2]	
IS 3176	Global Development [2]	
IS 3184	Human Security [2]	
IS 3594	Topics in Middle East Politics and International Relations	
IS 3634	Human Rights: Global Issues [2]	
IS 3894	Transatlantic Relations Since 1945	
IS 3924	Theories of Transatlantic Relations	
IS 3944	International Enrollment	
IS 3954	Study Abroad	
IS 4014	International Development [2]	
IS 4044	International Communication [2]	
IS 4054	Seminar in Global Political Economy [2]	
IS 4064	Seminar in Global Development [2]	
IS 4144	Topics in Transatlantic Relations	
IS 4184	Capstone Project Transatlantic Studies	
IS 4614	Senior Seminar in International Relations [2]	
IS 4734	Theories and Practices of International Conflict Management [2]	
IS 4974	Independent Study [6]	
IS 4984	Special Study [6]	
IS 4994	Undergraduate Research [6]	
Political Science (PSCI):		
PSCI 1014	Introduction to United States Government and Politics	
PSCI 3314	Congress [2]	
PSCI 3324	The Presidency [2]	
PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
PSCI 3514	Latin American Government and Politics [2]	
PSCI 3515	European Political Systems [2]	
PSCI 3516	European Political Systems [2]	
PSCI 3524	Politics of Post-Communist Systems [2]	
PSCI 3534	African Government and Politics [2]	
PSCI 3544	The State of Israel: A Political History [2]	
PSCI 3564	Violent Political Change [2]	
PSCI 3574	Government and Politics of Japan [2]	
PSCI 3584	Governments and Politics of Asia [2]	
PSCI 3684	Indigenous Peoples and World Politics [2]	
PSCI 3714	The U. S. Policy Process [2]	
PSCI 4514	Senior Seminar in Comparative Politics [2]	
Subtotal		15
Free Electives		
Select remaining credit hours to fulfill remaining credits required for graduation.		30
Subtotal		30
Pathways to General Education [7]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) fulfilled with IS 2004		
Pathways Concept 2 - Critical Thinking in the Humanities		

Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)	6
Pathways Concept 3 - Reasoning in the Social Sciences	
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) fulfilled with IS 2054 and IS 2064	
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [8]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) fulfilled with IS 1004	
Subtotal	33
Total Credits	**120**

1 Please note that not all courses are offered each semester. Check with the department offering the course to find out when courses are offered.

2 Check the Undergradate Course Catalog or the Timetable of classes for the most up to date course restrictions and prerequisites.

3 The content of the Independent Study or Special Study, as well as the topic of the Undergraduate Research should be relevant to the International Relations major. Please ask the International Studies advisor whether the proposed Independent Study or Special Study or Undergraduate Research topic qualifies.

4 IS 4964 is only offered as Pass/Fail and **can be used** toward fulfillment of a major elective from the corresponding list.

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete IS 1004 Nations and Nationalities, IS 1034 Introduction to International Studies and Political Science, IS 2004 Research and Writing in International Studies, IS 2054 Introduction to World Politics, IS 2064 The Global Economy and World Politics, IS 2084 The Evolution of World Order, and Foreign language 2105 & 2106 by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with an International Studies degree of which there are fifty-seven (57) required hours for the National Security & Foreign Affairs major.

In-major GPA

All of the courses in the core and major requirements and major electives are included in the in-major GPA calculation. A GPA of 2.0 or above both overall and in-major GPA is required for graduation.

Dual Use of Courses

In accordance with the State Council guidelines, courses used to fulfill the SCHEV approved degree core (Core Degree Requirements) may not also be used to meet the Pathways to General Education or major requirements.

Intra-departmental Majoring and Minoring

Due to overlapping of courses, students cannot pursue another major within the Department of Political Science. However, they can pursue any of the minors offered by the department except the minor in Political Science.

Prerequisites

Some courses listed on this checksheet have prerequisites; please consult the University Catalog and/or check with your advisor.

Foreign Language Requirement

University and Admissions Foreign Language Requirement (No Credits Count Toward the Degree)

*This is a requirement that is **separate** from the International Studies requirement.*
*Completion of this requirement **will not** fulfill your International Studies Language Requirement.*

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete 3 years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete 2 years of a single foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college (these 3 hours of 1106 do count toward the 120 required for graduation and calculates into the GPA)
    or
  - Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these 6 hours do **not** count toward the 120 required for graduation).

Modern and Classical Languages and Literatures

Our Website (https://liberalarts.vt.edu/departments-and-schools/department-of-modern-and-classical-languages-and-literatures.html)

Overview

Why study a language?

- 88% of job recruiters say speaking more than one language is critical to business success (Monster).
- Language study enhances any other major.
- Study abroad can be used to complete any language major or minor.
- AP and IB credits may be applied to prerequisites or requirements.
- Students of all majors are welcome in our classes.

Helpful hint: Best to start early because language courses must be taken in sequence and, if you have studied the language before, fluency declines quickly.

Click on the Programs tab above for major requirements. Click here for minor requirements (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/modern-classical-languages-literatures/Click here for minor requirements/).

Arabic Major, Arabic Minor
Chinese Studies Minor
Classical Studies Major, Classical Studies Minor, Classical Languages Minor
French Major, French Minor, French for Business Minor
German Major, German Minor
Italian Minor
Japanese Studies Minor
Language and Culture for the Practice of Science (LCPS) Minor (French or Spanish)
Latin Minor
Russian Major, Russian Minor
Spanish Major, Spanish Minor
For information on language clubs, study abroad, placement guides, contact information, faculty profiles, and more: Department of Modern and Classical Languages and Literatures (https://liberalarts.vt.edu/departments-and-schools/department-of-modern-and-classical-languages-and-literatures.html).

We also offer minors in these languages, as well as in Chinese, Italian, Japanese, and Latin. Click here for minor requirements (https://catalog.vt.edu/program-explorer/#filter=filter_5).

- Arabic Major (p. 1056)
- Classical Studies Major (p. 1057)
- French Major (p. 1059)
- German Major (p. 1060)
- Russian Major (p. 1061)
- Spanish Major (p. 1062)

Chair: J. Folkart
Professors: C. Andrango-Walker, A. Dickow, J. Folkart (chair), A. Gudmestad (Associate Chair), C. Noirot, D. Stoudt, V. Venkatesh, J. Watson
Associate Professors: E. Austin, E. Bauer, A. Becker, M.C. Cana-Jimenez, M. Coburn, R. Efird, M. Gueye, S. Hofer, S. Johnson, N. Milman-Miller, Y. Minkova, G. Montero, R. Phillips, P. Ridge, R. Shryock, S. Sierra, N. Sinno, M.C. Teo, T. Zhao
Assistant Professors: J. Jaque, B. Klausmeyer, J. Sather, T. Wilson
Instructors: R. Chang, A. Dalton, J. M. Layne, S. Mishra, M. Onakado, Y. Slivkin, S. Simmerman, W. Taggart
Advanced Instructors: Y. Kumazawa, R. Nassereddine, M. Sguerri, C. Steer
Senior Instructor: N. Lopez-Romero
Professors of Practice: A. Sobrado
Collegiate Assistant Professors: D. Delgado Lopez, A. Hesp, K. Rutsala
Visiting Assistant Professor: J. Al-Ahmad, R. Stauffer

Undergraduate Course Descriptions (FL)

FL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2774 - Multilingualism and Language Contact (3 credits)
Exploration of multilingualism as a social and linguistic phenomenon. Examination of language practices in multilingual contexts around the world. Analysis of current socio-political policies pertaining to language in situations of language contact. Discussion of linguistic rights, such as economic opportunities, education, and national languages, and their connection to world affairs. Exploration of language revitalization efforts for endangered languages. Taught in English.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CHN)

CHN 1105 - Elementary Chinese (3 credits)
Fundamentals of the Chinese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Chinese.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 1106 - Elementary Chinese (3 credits)
Fundamentals of the Chinese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Chinese.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 1114 - Accelerated Elementary Chinese (6 credits)
Proficiency-oriented approach to Elementary Chinese, designed for learners who wish to progress rapidly through the beginning stages of language learning. Speaking, listening comprehension, reading comprehension, writing, and cultural competency at the novice-high level. Duplicates 1105 and 1106. For students with no prior knowledge of the language.
Instructional Contact Hours: (6 Lec, 6 Crd)

CHN 2105 - Intermediate Chinese (3 credits)
Emphasizes comprehension of written and spoken Mandarin Chinese, communication in Chinese; study of some literature and culture of the Chinese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): CHN 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2106 - Intermediate Chinese (3 credits)
Emphasizes comprehension of written and spoken Mandarin Chinese, communication in Chinese; study of some literature and culture of the Chinese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): CHN 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2734 - Chinese Culture and Civilization (3 credits)
Survey of Chinese culture and civilization through interactions between major political and historical events, social and artistic movements in China. Chinese literature, art, architecture, film, and theater in the context of Chinese cultural history. Aesthetic and rhetorical strategies. Interpretation of intercultural experiences from different vantage points. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 3105 - Advanced Chinese (3 credits)
3105: Practice in communication skills in Chinese both orally and in writing, including review of grammar, directed composition, and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3106 - Advanced Chinese (3 credits)
3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): CHN 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3124 - Chinese for Oral Proficiency (3 credits)
Formal conversation, business Chinese, and enhanced cultural competency. Discuss current topics and perform daily transactions. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3304 - Chinese Literature in Translation (3 credits)
Familiarization with the historical, intellectual, and cultural contexts of major Chinese literary genres. Identification of major cultural movements and concepts in Chinese literature and analysis of literary texts. Examination of aesthetic and rhetorical strategies employed in literary works. Intercultural experiences from different vantage points. The impact of globalization on Chinese literature. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3474 - Topics in Chinese Cinema (3 credits)
Critical issues in the history of modern and contemporary China through cinema. Interactions between major political and historical events and social and cultural movements in China. Chinese cinema in the broader contexts of Chinese cultural history and Chinese society. Interpretation of intercultural experiences from different vantage points. Variable topics such as national identity, social realities during the Republican era, the modernization of China, economic conditions and political responses, gender politics, the reform and opening-up of China, and the impact of globalization on Chinese cinema. Instruction in English. May be repeated once with different content for a maximum of 6 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CHN 3514 - Modern China through the Media (3 credits)
Acquisition of media Chinese through comprehending and analyzing various forms of mass media. Topics of community, national, or international interest. Language used in both formal and informal settings. Enhancement of societal and cultural knowledge through the mass media. Not recommended for native speakers.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3524 - Introduction to Chinese Translation (3 credits)
Introduction to the translation of a variety of real-world materials from Chinese into English with the aid of online translation tools. Acquisition of relevant skills to analyze Chinese sentences into phrasal constituents, critique the quality of existing translated works, and create a portfolio of translation work.
Prerequisite(s): CHN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3534 - Business Chinese (3 credits)
Preparation for the business world in contemporary Modern Standard Chinese-speaking communities. Contextualized usage of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in spoken and written formats such as business correspondence, formal and informal reports, business documents, and business proposals. Taught in Chinese. Not recommended for native speakers.
Prerequisite(s): CHN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3544 - Introduction to Classical Chinese (3 credits)
Essentials of classical Chinese vocabulary and grammar. Simple texts in classical Chinese, translation of classical Chinese texts into idiomatic English, and recitations of selected short passages in the language. Not recommended for native speakers. Taught in Chinese.
Prerequisite(s): CHN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3604 - Chinese Language and Society (3 credits)
Examination of the complex interaction between linguistic practices and social and cultural stratifications in Chinese speaking communities (e.g., Mandarin speakers). Identification of fundamental concepts in the field of sociolinguistics, explanation of the ways in which language expresses different social meanings, analysis of how identity is constructed through language and how belief systems about different identities influence human behavior and social relationships, identification of issues of diversity and inclusion, and interpretation of language behavior from different sociocultural contexts. Taught in English.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4614 - Teaching Chinese (3 credits)
Focus on practical activities of language learning, from a variety of learners' perspectives. Development of the ability to explain and apply activities for learning Chinese characters, sounds, vocabulary, and sentence patterns; ability to design conversation-based practice tasks.
Prerequisite(s): CHN 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

CHN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (CLA)

CLA 1134 - The Ancient Mediterranean World (3 credits)
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as their influence on later and modern cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 1134

CLA 2224 - Ancient Greek and Roman Women (3 credits)
Examines the history of ancient Greek and Roman women from ninth century BCE to the fall of the Roman Empire. Analyzes contributions of women to each civilization. Studies construction of and contemporary debates about women's ascribed social, political, and cultural roles.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2224

CLA 2234 - Classics in the Modern World (3 credits)
Examines the influences, traditions, and receptions of the ancient Greeks and Romans in the modern world, especially in the United States. Explores the re-interpretation of the ancient Greek and Roman world across mediums, and by leaders and governments in diverse societies. Discusses contexts and ideologies of re-makings of the ancient Greek and Roman world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2234

CLA 2244 - Cities of Rome (3 credits)
Examines the building development of the ancient city of Rome and selected Roman cities; investigates how social, political, and cultural aspects of private and public architecture in these physical cities both create meaning and preserve memory. Explores the ways in which later cultures, especially through literature, have engaged with the pervasive and persistent influence of ancient Rome, not just as a physical place, but also as a cultural construct.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2244

CLA 2434 - Fairytale, Folklore, and Magic: Popular Literature in Ancient Greece and Rome (3 credits)
Survey of ancient Greek and Roman popular literature. Introduces students to a wide array of texts, ranging from the ancient novel, popular compilations (e.g. books of marvels, fables, and jokes), ritual texts, funerary inscriptions, and folklore/fairytales. Examination of how scholars define popular literature as a category and introduction of contemporary approaches to it. Exploration of the connection of ancient Greek and Roman tales to international ones from different cultures and perspectives. Special attention to the depiction of private rituals in Greek and Latin literature. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CLA 2444 - Ancient Greek and Roman Mythology (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2444, RLCL 2444

CLA 2454 - Topics in Ancient Greek and Latin Literature (3 credits)
Examines canonical and non-canonical ancient Greek and Latin literary texts in translation and subsequent uses, adaptations and interpretations of these texts in various cultures. Examines concepts common to the humanities. Investigates the interaction and interdependence of literary texts with philosophy, art, music, history, and society. Identifies the uses, influences, and interpretation of these literatures. Examines significance of ancient Greek and Latin literature even though distant from our own space, time and experience. Identifies instances of cultural diversity and inclusion in these works. Taught in English. May be repeated 2 times with different content for a maximum of 9 credit hours.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CLA 2464 - Mythology, Philosophy and Video Games (3 credits)
Examines how both ancient texts and modern games convey fundamental concepts of the humanities such as community, communication, agency, archetypes, the monomyth, morality, ethics, gender issues, environmental issues, aesthetic experience, xenophobia, and xenophilia. Evaluates the interaction of philosophy, art, technology, mythology, society and entertainment, and combines uses of modern technology and functions of ancient mythology across cultures and communities. Demonstrates the integration of concepts of the humanities as presented in video games.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CLA 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CLA 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (FR)

FR 1105 - Elementary French (3 credits)
Fundamentals of the French language with emphasis on grammar, reading, composition, and conversation. 1105 for students with no prior knowledge of the language; 1106 for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 1106 - Elementary French (3 credits)
Fundamentals of the French language with emphasis on grammar, reading, composition, and conversation. 1105 for students with no prior knowledge of the language; 1106 for students who have completed 1105 or less than three years in high school.
Prerequisite(s): FR 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 1114 - Accelerated Elementary French (6 credits)
Proficiency-oriented approach to Elementary French, designed for learners who wish to progress rapidly through the beginning stages of language learning. Development of the four language skills (speaking, listening, reading, writing) and basic cultural competency through the study of authentic materials. Duplicates FR 1105 and FR 1106. Taught in French.
Instructional Contact Hours: (6 Lec, 6 Crd)

FR 2105 - Intermediate French (3 credits)
Emphasizes comprehension of written and spoken French, communication in French, literature, and culture of French-speaking world.
Prerequisite(s): FR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2106 - Intermediate French (3 credits)
Emphasizes comprehension of written and spoken French, communication in French, literature, and culture of French-speaking world.
Prerequisite(s): FR 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2114 - Accelerated Intermediate French (6 credits)
Proficiency-oriented approach to intermediate French, designed for learners who wish to progress rapidly through the intermediate stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context using authentic materials. Taught in French. Accelerated version of 2105-2106. Duplicates 2105-2106.
Prerequisite(s): FR 1106 or FR 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

FR 2164 - Intermediate Business French (3 credits)
This course emphasizes all four language skills (reading, writing, speaking, and listening) by focusing on various facets of the world of business and technology. It also develops students understanding of French institutions and business practices.
Prerequisite(s): FR 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 2714 - Introduction to French Culture and Civilization (3 credits)
French culture and civilization from prehistoric cave paintings to the present. Interdisciplinary approach to literature, film, art, achitecture, intellectual movements, and lifestyle in the context of French political history, society, and globalization, including elements of French culture that arrived through conquerors, migrants, and immigrants. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

FR 2794H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

FR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 3105 - Composition, Conversation and Grammar (3 credits)
Development of the ability to write and speak through the effective use of French syntax and morphology. Increased reading and listening skills through the study of authentic materials in the target language. Understanding the role of culture in communication. Conducted in French.
Prerequisite(s): FR 2106 or FR 2164
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3106 - Composition, Conversation and Grammar (3 credits)
Development of the ability to write and speak through the effective use of French syntax and morphology. Increased reading and listening skills through the study of authentic materials in the target language. Understanding the role of culture in communication. Conducted in French.
Prerequisite(s): FR 2106 or FR 2164
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3125 - French for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken French. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S -1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the ACTFL-OPI or a 2 on the FSI scale. Admission by oral exam.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3126 - French for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken French. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S -1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the ACTFL-OPI or a 2 on the FSI scale. Admission by oral exam.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3154 - French for the Natural Sciences (3 credits)
Knowledge of the French language and its cultures to the natural sciences. Study of scientific materials in French. Practice in communication skills through contextualized use of specific vocabulary, idiomatic expressions, grammar structures and cultural practices in real-world situations. Discussion on scientific topics and debates of the French-speaking world. Comparison of the practices and world views of scientists and clinicians in French and English-speaking countries. Taught in French.
Prerequisite(s): FR 3106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3164 - Advanced Business French (3 credits)
In this skills-based course, students learn to use appropriate French technical vocabulary for different business contexts, do translation, write professional correspondence, and read articles related to the worlds of business, economics, and finance. Cross-cultural differences regarding the work place are also a focus of the course.
Prerequisite(s): FR 3105 and FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3304 - Introduction to French Literature (3 credits)
Introduction to French literature through analysis and discussion of selected texts from different periods and genres. Methods, terminology, and practice of literary analysis. Intensive writing component.
Prerequisite(s): FR 3105 or FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3314 - Introduction to Francophone Studies (3 credits)
Introduction to the literatures and cultures of French-speaking regions outside of France including North Africa, the Caribbean, Sub-Saharan Africa, and Quebec. Examination of thematic and cultural aspects of literatures of those regions within their socio-historical contexts. Exploration of movements and notions as Negritude, postcolonialism, identity, race, and nation as they relate to the legacy of colonial France. Development of research skills such as finding appropriate sources and proper citation, and of intercultural sensitivity through analysis of works outside Western traditions. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3424 - French Culture from Middle Ages to Renaissance (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from the Middle Aes to the end of the Renaissance. Emphasis on nation-building and cultural production. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts affects from a chronological and thematic perspective. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3434 - French Culture from Baroque to Revolution (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from the Baroque era to the French Revolution (1610-1799). Emphasis on nation-building and cultural production in a European and Global context. Critical reading and writing in French. Analysis of a variety of literary texts and cultural artifacts from a chronological and thematic perspective. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3444 - French Culture from Romanticism to Belle Epoque (3 credits)
Overview of major events, movements, ideas, works, and figures in French culture from the Romantic period (1800) through the Belle Epoque (1914). Emphasis on literary and cultural works in their social and historical contexts. Critical reading and analysis in French. Study of the impact of French history on French culture. Interpretation of intercultural experiences according to different world views. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3454 - French Culture from World Wars to Global Present (3 credits)
Overview of major events, currents, ideas, works, and figures in French culture from World War I to the present, a period characterized by colonialism, world conflict, and globalization. Analysis of literary and cultural works in their social and historical contexts, toward an understanding of the French language as a global idiom involving diverse worldviews and cultures. Critical reading and writing in French. Taught in French.
Prerequisite(s): FR 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4154 - Advanced Composition and Stylistics (3 credits)
Intensive work in written French. Development of the students ability to write clear, correct, and articulate French in a variety of modes (e.g., epistolary style, the formal and informal essay). Writing intensive.
Prerequisite(s): FR 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

FR 4164 - Special Topics in Business French (3 credits)
A variable content course devoted to developing and perfecting highly advanced language skills through the study of special topics in the French and francophone business worlds. Emphasis on a mastery of specialized French for professional settings. May be repeated for credit with different content. Taught even years.
Prerequisite(s): FR 3106 and FR 3164
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 998.99 credit hours

FR 4314 - Studies in French Literature (3 credits)
In-depth study of a selected topic in French literature, such as an author, a group of authors, a literary movement or genre during a specific period of French literary history (i.e., Voltaire, the Pleiade, Romanticism, the nouveau roman). May be repeated for credit with different content.
Prerequisite(s): FR 3304 and (FR 3314 or FR 3424 or FR 3434 or FR 3444 or FR 3454)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

FR 4324 - Special Topics in French Life, Literature and Language (3 credits)
In-depth study of a selected topic in French culture or language as manifested in creative and historical literature, music, art, film, etc., such as phonetics, translation techniques, or the staging of dramatic works in French. May be repeated for credit with different content.
Prerequisite(s): FR 3304 and (FR 3314 or FR 3424 or FR 3434 or FR 3444 or FR 3454)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

FR 4794 - Senior Tutorial in French Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level French course, senior standing, French major, and consent of French Section required.
Instructional Contact Hours: (1 Lec, 1 Crd)

FR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (GER)

GER 1105 - Elementary German (3 credits)
Fundamentals of the German language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 1106 - Elementary German (3 credits)
Fundamentals of the German language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Prerequisite(s): GER 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 1114 - Accelerated Elementary German (6 credits)
Proficiency-oriented approach to elementary German, designed for learners who wish to progress rapidly through the beginning stages of language learning. It develops the four language skills (speaking, listening, reading, writing) in a cultural context. Partially duplicates GER 1105 and 1106.
Instructional Contact Hours: (6 Lec, 6 Crd)

GER 2105 - Intermediate German (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): GER 1106 or GER 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2106 - Intermediate German (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication. I,II
Prerequisite(s): GER 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2114 - Accelerated Intermediate German (6 credits)
Proficiency-oriented approach to intermediate German, designed for learners who wish to progress rapidly through the intermediate stages of language learning. The course strengthens the four language skills (speaking, listening, reading and writing) in a cultural context. Accelerated version of GER 2105-2106.
Prerequisite(s): GER 1106
Instructional Contact Hours: (6 Lec, 6 Crd)

GER 2724 - Introduction to German Culture and Civilization (3 credits)
Examination of major German-language cultural movements, works, and figures from the earliest times to the present. Interdisciplinary exploration of German-language literature, film, art, architecture, music, and theatre in the context of the history of the German-speaking world. Analysis of Germanic culture, values and beliefs, and politics in their European and international context. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 3105 - Grammar, Composition and Conversation (3 credits)
Progressive and comprehensive review of German syntax and morphology. Development of written and oral expression. Development of reading and listening skills and introduction to contemporary public debates through the study of original German materials. Understanding of the role of social, historical, political, and cultural contexts and of fact-based reasoning in communication. Introduction to cultural research in German. Taught in German. GER 3105: review of basic and complex grammatical structures; GER 3106: review of advanced grammatical structures, writing intensive.
Prerequisite(s): GER 2106 or GER 2114
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3106 - Grammar, Composition and Conversation (3 credits)
Progressive and comprehensive review of German syntax and morphology. Development of written and oral expression. Development of reading and listening skills and introduction to contemporary public debates through the study of original German materials. Understanding of the role of social, historical, political, and cultural contexts and of fact-based reasoning in communication. Introduction to cultural research in German. Taught in German. GER 3105: review of basic and complex grammatical structures; GER 3106: review of advanced grammatical structures, writing intensive.
Prerequisite(s): GER 3105
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3125 - German Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken German. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3126 - German Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken German. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3204 - Culture of the German-Speaking Countries (3 credits)
Study of German, Austrian, and Swiss culture and civilization from the Middle Ages to the present, including literature, art, architecture, film, and music.
Prerequisite(s): GER 3104 or GER 3105 or GER 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 3305 - Topics in German Culture and Literature (3 credits)
Introduces students to critical issues in German culture and literature. Familiarizes students with artistic, cultural, and socio-historical contexts necessary to analyze artifacts (canonical and non-canonical literature, film, art, architecture, and music). Develops critical reading, writing, speaking, and listening skills in German regarding complex texts, contexts, and concepts. Fosters cross-cultural awareness and intercultural sensitivity. 3305: examines pre-20th-century German cultural and literary developments; 3306: examines cultural and literary developments in the 20th and 21st centuries. Taught in German. Variable content. May be repeated once for credit with different content for a maximum of 6 credits.
Prerequisite(s): (GER 3105 and GER 3106) or (GER 3105 and GER 3204) or (GER 3105 and GER 3306) or (GER 3106 and GER 3204) or (GER 3106 and GER 3306)
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3306 - Topics in German Culture and Literature (3 credits)
Introduces students to critical issues in German culture and literature. Familiarizes students with artistic, cultural, and socio-historical contexts necessary to analyze artifacts (canonical and non-canonical literature, film, art, architecture, and music). Develops critical reading, writing, speaking, and listening skills in German regarding complex texts, contexts, and concepts. Fosters cross-cultural awareness and intercultural sensitivity. 3305: examines pre-20th-century German cultural and literary developments; 3306: examines cultural and literary developments in the 20th and 21st centuries. Taught in German. Variable content. May be repeated once for credit with different content for a maximum of 6 credits.
Prerequisite(s): GER 3105 or GER 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3474 - Topics in German Cinema (3 credits)
Critical issues in the history of German Cinema. Aesthetic characteristics of major periods, with an emphasis on cinematic trends and ways in which films reflect cultural developments in German-speaking countries. Taught in English. Variable content. May be taken twice for credit with different content.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

GER 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4154 - Advanced Composition and Stylistics (3 credits)
Intensive advanced work in written German. Development of the students ability to write clear, correct, and articulate German in a variety of modes. Style analysis. Writing intensive.
Prerequisite(s): GER 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4304 - Age of Goethe (3 credits)
Major writers of the age of Goethe: Goethe, and Schiller; the development of German Classicism.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4314 - Studies in 19th-Century Literature (3 credits)
Variable content course devoted to the study of 19th century drama, lyric, and prose. May be repeated for credit with different content.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4324 - Studies in 20th-Century Literature (3 credits)
A variable content course devoted to the study of major literary works of the 20th century. May be repeated for credit with different content.
Prerequisite(s): GER 3105 and GER 3106 and GER 3306
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4334 - Special Topics in German Life, Literature, and Language (3 credits)
Variable content course devoted to the study of various aspects of German culture, literature, and language. May be repeated for credit with different content.
Prerequisite(s): (GER 3105 and GER 3106) and (GER 3204 or GER 3305 or GER 3306)
Instructional Contact Hours: (3 Lec, 3 Crd)

GER 4794 - Senior Tutorial in German Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. Must be pre-arranged three weeks before end of previous semester. May be taken twice for credit with different content. PRE: one 4000-level German course, major with senior standing, and consent required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

GER 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GER 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (GR)

GR 1105 - Classical and New Testament Greek (3 credits)
Introduction to classical/New Testament Greek, for development of reading ability. 1105: Short readings of graded difficulty. 1106: Introduction to the basics of the introduction of language, continued, with the introduction of select longer passages from ancient Greek authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1106 - Classical and New Testament Greek (3 credits)
Introduction to classical/New Testament Greek, for development of reading ability. 1105: Accidence, syntax, and vocabulary, with translation of short readings of graded difficulty. 1106: Accidence, syntax, and vocabulary continued, with the introduction of selected longer passages from ancient Greek authors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1205 - Elementary Modern Greek (3 credits)
Fundamentals of modern Greek with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. GR 1205 is for students with no prior knowledge of the language.
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 1206 - Elementary Modern Greek (3 credits)
Fundamentals of modern Greek with emphasis on developing proficiency for communication through reading, writing, speaking, listening, and cultural competence. GR 1206 is for students who have completed GR 1205 or the equivalent. Completion of 1206 meets the university foreign language requirement.
Prerequisite(s): GR 1205
Instructional Contact Hours: (3 Lec, 3 Crd)

GR 2104 - Greek New Testament (3 credits)
Review and refinement of the language is combined with readings from the New Testament in ancient Greek, with attention to historical context and analysis of the language May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: RLCL 2104

GR 2114 - Readings in Classical Greek Literature (3 credits)
Study of several major writers of ancient Greek literature. Selections from epic poetry, tragedies, philosophical dialogues, history and oratory. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

GR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (HEB)

HEB 1105 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 1105

HEB 1106 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): HEB 1105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 1106

HEB 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

HEB 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HEB 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

HEB 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (ITAL)

ITAL 1105 - Elementary Italian (3 credits)
Fundamentals of the Italian language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 1106 - Elementary Italian (3 credits)
Fundamentals of the Italian language with emphasis on grammar, reading, composition, and conversation. 1105: for students with no prior knowledge of the language; 1106: for students who have completed 1105 or less than three years in high school.
Prerequisite(s): ITAL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 1204 - Italian Language and Cultures (1-3 credits)
Fundamentals of the Italian Language with emphasis on developing proficiency in practical language use and cultural competency. Offered off campus. Does not fulfill the University foreign language requirement. Variable credit course.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)

ITAL 2105 - Intermediate Italian (3 credits)
Emphasizes comprehension of written and spoken Italian, communication in Italian, literature, and culture of Italy.
Prerequisite(s): ITAL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 2106 - Intermediate Italian (3 credits)
Emphasizes comprehension of written and spoken Italian, communication in Italian, literature, and culture of Italy.
Prerequisite(s): ITAL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ITAL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 2984B - Special Study (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

ITAL 3105 - Culture Composition and Conversation (3 credits)
Practice in oral and written communication in Italian on a variety of topics in Italian culture. Progressive and comprehensive review of Italian grammar. Expansion of vocabulary.
Prerequisite(s): ITAL 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3106 - Culture Composition and Conversation (3 credits)
Practice in oral and written communication in Italian on a variety of topics in Italian culture. Progressive and comprehensive review of Italian grammar. Expansion of vocabulary.
Prerequisite(s): ITAL 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3305 - Introduction to Italian Literature in Context (3 credits)
Overview of genres and themes of Italian literature from national unification to the present. Familiarizes students with the socio-historical context necessary to discuss and write critically about this literature. 3305 examines the period from unification until the end of World War II including representations of national identity at the time of unification and beyond, generic experimentalism, resistance and complicity in the Fascist era, social realities during World War II. 3306: examines the period from the end of World War II to the present including retrospective debates about historical eras, economic conditions and political responses, gender politics, the influence of specific historical migrations on literature. Taught in Italian.
Prerequisite(s): ITAL 3105 or ITAL 3106
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3306 - Introduction to Italian Literature in Context (3 credits)
Overview of genres and themes of Italian literature from national unification to the present. Familiarizes students with the socio-historical context necessary to discuss and write critically about this literature. 3305 examines the period from unification until the end of World War II including representations of national identity at the time of unification and beyond, generic experimentalism, resistance and complicity in the Fascist era, social realities during World War II. 3306: examines the period from the end of World War II to the present including retrospective debates about historical eras, economic conditions and political responses, gender politics, the influence of specific historical migrations on literature. Taught in Italian.
Prerequisite(s): ITAL 3105 or ITAL 3106
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

ITAL 3474 - Topics in Italian Cinema (3 credits)
Critical issues in the history of modern and contemporary Italy through cinema, with an emphasis on films produced in Italy that most reflect the nation, its culture and society, and its cinematic trends. Students will discuss and write about the cultural, intellectual, and historical contexts present in Italian cinematic works. Sample topics, depending on the given semester, include organized crime, immigration, the urbanization of Italy, and neorealism. Taught in English. May be repeated, with different content, for a maximum of 6 credit hours.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

ITAL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ITAL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ITAL 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (JPN)

JPN 1105 - Elementary Japanese (3 credits)
Fundamentals of the Japanese language with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one year, but less than three years of high school Japanese.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 1106 - Elementary Japanese (3 credits)
Fundamentals of the Japanese language, with emphasis on developing proficiency in practical language use and cultural competency. 1105 is for students with no prior knowledge of the language; 1106 is for students who have completed 1105, or more than one, but less than three, units of high school Japanese.
Prerequisite(s): JPN 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 1114 - Accelerated Elementary Japanese (6 credits)
Proficiency-oriented approach to Elementary Japanese, designed for learners who wish to progress rapidly through the beginning stages of language learning. Speaking, listening comprehension, reading comprehension, writing, and cultural competency at the JLPT (Japanese Language Proficiency Test) level 4 (ACTFL novice-high). Accelerated version of 1105-1106. Duplicates 1105 and 1106. For students with no prior knowledge of the language.
Instructional Contact Hours: (6 Lec, 6 Crd)

JPN 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 19 credit hours

JPN 2105 - Intermediate Japanese (3 credits)
Emphasizes comprehension of written and spoken Japanese, communication in Japanese; study of some literature and culture of the Japanese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): JPN 1106 or JPN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2106 - Intermediate Japanese (3 credits)
Emphasizes comprehension of written and spoken Japanese, communication in Japanese; study of some literature and culture of the Japanese people. 2105 is for students who have completed 1105 and 1106 or equivalent. 2106 is for students who have completed 2105 or equivalent.
Prerequisite(s): JPN 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2114 - Accelerated Intermediate Japanese (6 credits)
Proficiency-oriented approach to Intermediate Japanese, designed for highly motivated learners who wish to progress rapidly through the intermediate stages of language learning or those with some prior experience in Japanese in need of intensive review. Emphasis on reading, writing, listening, and oral communication, and review of intermediate grammar and vocabulary in guided oral and written assignments in tasks such as jobs (full and part time), holidays, vacations, shopping, and education. Study of authentic materials and cultural artifacts in Japanese. Accelerated version of 2105-2106. Duplicates 2105 and 2106. Not recommended for advanced or native speakers of Japanese.
Prerequisite(s): JPN 1106 or JPN 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

JPN 2744 - From Atom to Akira: Japan's Pop Culture (3 credits)
Analysis of Japanese popular culture through anime (animation), manga (comics), and video games. Introduction of important socio-cultural issues in Japan such as language, ideology, identity, gender, race, class, and nationalism. Exploration of the domestic and global popularity of these mediums and their socio-historical contexts, styles, and characteristics. Fostering of cross-cultural awareness and intercultural understanding by addressing global challenges and opportunities in Japan through popular culture. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 3105 - Advanced Japanese (3 credits)
3105: Practice in communication skills in Japanese both orally and writing, including review of grammar, directed composition and conversation, with an emphasis on pronunciation, cultural competency, and oral expressions. Not recommended for native speakers. 3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): JPN 2106 or JPN 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3106 - Advanced Japanese (3 credits)
3106: Reinforcement of oral proficiency, reading, grammar, and writing skills, allowing students to explore a broad range of texts of general and professional interest. Not recommended for native speakers.
Prerequisite(s): JPN 3105
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3125 - Japanese for Oral Proficiency (3 credits)
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. 3125: Provides students with the ability to converse in every day Japanese conversation. Focus on everyday conversational skills including life topics, transactions, and Japanese media. Emphasis on appropriate body language and understanding of cultural, political, and religious knowledge. 3126: Provides students with the ability to converse in advanced and complex situations. Focus on formal conversations (honorific, humble, and extra-polite) and business Japanese. Not recommended for native speakers.
Prerequisite(s): JPN 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3126 - Japanese for Oral Proficiency (3 credits)
Devoted to the acquisition of spoken dialect and the enhancement of cultural competency. 3125: Provides students with the ability to converse in every day Japanese conversation. Focus on everyday conversational skills including life topics, transactions, and Japanese media. Emphasis on appropriate body language and understanding of cultural, political, and religious knowledge. 3126: Provides students with the ability to converse in advanced and complex situations. Focus on formal conversations (honorific, humble, and extra-polite) and business Japanese. Not recommended for native speakers.
Prerequisite(s): JPN 3125
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3304 - Japanese Literature in Translation (3 credits)
Overview of genres, themes, and narrative strategies characteristic of Japanese literature and other cultural artifacts, as well as the various historical and cultural contexts from which they arose. Exploration of themes, such as transience, honor, and community, with a particular focus on change and evolution over time. Assessment of literature and cultural artifacts' rendering of and impact on the construction of Japanese identity, such as race, gender, and sexuality. Creation of cross-cultural awareness by distinguishing the influence of other literary traditions on Japan's literature. Development of intercultural understanding by analyzing common themes in Japanese literature and culture and their implications not just for Japanese life, but also for how they interact with broader global concerns. Taught in English.
Prerequisite(s): ENGL 1106 and ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3474 - Topics in Japanese Cinema (3 credits)
Evaluation of the socio-cultural contexts and perspectives of Japanese cinema, including Japanese cinema's ability both to produce and reproduce socio-cultural contexts like the political, religious, or aesthetic constructs of a particular time period. Explanation of the relationship between those contexts and films, such as the anti-war stance of many pre-WWII directors or the impact of Japan's 1989 financial collapse on cinema. Development of a coherent understanding of Japanese cinema and cinematic techniques through films and literary sources, both primary in translation and secondary. Analysis of intercultural perspectives, such as the influence of American and European films on Japanese cinema and vice-versa, in relation to a student's own cinematic tradition. Comparison of intercultural experiences with broader global concerns, challenges, and opportunities as expressed through Japanese film. Taught in English. Variable content. May be repeated twice with different content for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

JPN 3724 - Modern Japanese Culture and Society (3 credits)
Overview of Japanese society and culture through analysis of Japanese language texts and other cultural artifacts, with an emphasis on modern Japan. Examination of socio-cultural and linguistic factors that have influenced the development of modern Japan and Japanese identity, such as its focus on community, weakened financial clout, growing cultural capital. Exploration of the impact of issues such as aging, work-life balance, globalization, and gender norms that continue to shape modern Japanese society, and relating them to students' lives. Assessment of these issues within regional (Asian) and global contexts. Taught in Japanese.
Prerequisite(s): JPN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4104 - Japanese Advanced Grammar (3 credits)
Advanced Japanese grammar skills. Use of special verbs in honorific, extra-modest, and humble form. Analysis and writing of personal and professional texts. Question formation within larger sentences, naming items, using passive and passive-causative sentences. Development of the ability to read, write, and apply the use of 317 intermediate-level kanji in various contexts.
Prerequisite(s): JPN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

JPN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

JPN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (KOR)

KOR 1105 - Elementary Korean (3 credits)
Introduction to speaking, listening, reading, and writing the Korean language. Emphasis on developing proficiency in practical language use, comprehension, and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: Transactions like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)

KOR 1106 - Elementary Korean (3 credits)
Introduction to speaking, listening, reading, and writing the Korean language. Emphasis on developing proficiency in practical language use, comprehension, and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: Transactions like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): KOR 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

Undergraduate Course Descriptions (LAT)

LAT 1105 - Elementary Latin (3 credits)
Introduction to Latin, for development of reading ability. 1105: Introduction to the basics of the language and short readings of graded difficulty. 1106: Introduction to the basics of the language, continued, with introduction of selected passages from ancient Roman authors for reading, comprehension, and translation.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 1106 - Elementary Latin (3 credits)
Introduction to Latin, for development of reading ability. 1105: Accidence, syntax, and vocabulary, with translation of discrete sentences and short readings of graded difficulty. 1106: Accidence, syntax, and vocabulary continued, with the introduction of selected passages from ancient Roman authors for reading, comprehension, and translation.
Prerequisite(s): LAT 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 2104 - Cicero and Livy (3 credits)
A course in two major Latin prose authors. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2114 - Latin Epic: Vergil and Ovid (3 credits)
A course in two important Latin poets of the Age of Augustus with a view to increasing the students ability to understand and read Latin. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2124 - Latin Lyric: Catullus and Horace (3 credits)
Two important Latin poets of the Late Republic. Review and refinement of the language is combined with an increasing attention to historical, linguistic, cultural, and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1105 and LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2134 - Late Medieval Latin (3 credits)
Post-classical Latin, from Augustine and Boethius through the Middle Ages, Renaissance, and the Modern Age. Review and refinement of the language is combined with an increasing attention to historical, cultural, linguistic and literary questions. May be repeated with different content for a maximum of 9 credits.
Prerequisite(s): LAT 1105 and LAT 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

LAT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

LAT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 3004 - Readings in Latin Literature (3 credits)
A variable content course devoted to the study of major Latin texts not offered in the 2000-level courses. Emphasis is on content, style, and context. May be repeated for credit with different content. Two 2000-level courses in Latin or equivalent proficiency required. Writing Intensive.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 4004 - Directed Studies in Latin Prose Composition (3 credits)
Application of Latin grammar structure to the translation of English into Latin. Original compositions are written in Latin. (Will be offered during the academic year whenever there is sufficient enrollment and available staffing). One 3000-level course in Latin required.
Instructional Contact Hours: (3 Lec, 3 Crd)

LAT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

LAT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

LAT 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (PORT)

PORT 1106 - Beginning Conversational Portuguese (3 credits)
Essential vocabulary and structures of the Portuguese language as spoken in Brazil; emphasis on active spoken and written use of the language for practical daily purposes.
Instructional Contact Hours: (3 Lec, 3 Crd)

PORT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PORT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (RUS)

RUS 1105 - Elementary Russian (3 credits)
Fundamentals of grammar, pronunciation, conversation, and reading. Respond to simple questions using appropriate grammar and syntax, participate in conversation about family, school, everyday situations, etc., write in cursive, and read adapted texts. 1105: Grammar and conversation; 1106: Grammar, conversation, and reading.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 1106 - Elementary Russian (3 credits)
Fundamentals of grammar, pronunciation, conversation, and reading. Respond to simple questions using appropriate grammar and syntax, participate in conversation about family, school, everyday situations, etc., write in cursive, and read adapted texts. 1105: Grammar and conversation; 1106: Grammar, conversation, and reading.
Prerequisite(s): RUS 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 1114 - Accelerated Elementary Russian (6 credits)
Proficiency-oriented approach to elementary Russian, designed for learners who wish to progress rapidly through the beginning stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 1105 and 1106.
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 2105 - Intermediate Russian (3 credits)
Grammar, reading, conversation, and composition. Emphasizes comprehension of written and spoken Russian.
Prerequisite(s): RUS 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2106 - Intermediate Russian (3 credits)
Grammar, reading, conversation, and composition. Emphasizes comprehension of written and spoken Russian.
Prerequisite(s): RUS 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2114 - Accelerated Intermediate Russian (6 credits)
Proficiency-oriented approach to intermediate Russian for learners who wish to progress rapidly through the intermediate stages of language learning. Develops the four language skills (speaking, listening, reading, writing) in a cultural context. Duplicates 2105 and 2106.
Prerequisite(s): RUS 1106 or RUS 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 2734 - Introduction to Russian Culture and Civilization (3 credits)
Introduction to Russian Culture and Civilization. Interactions between major political and historical events, social and artistic movements in Russia. Russian literature, art, architecture, film, and theatre in the context of Russian cultural history. Aesthetic and rhetorical strategies. Interpretation of intercultural experiences from different vantage points. Taught in English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 3105 - Grammar, Composition and Conversation (3 credits)
Detailed study of grammar. Practice in written and oral expression in Russian on a variety of topics. Supplementary readings to emphasize application of grammatical principles. 3105 includes a rapid grammatical review.
Prerequisite(s): RUS 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3106 - Grammar, Composition and Conversation (3 credits)
Detailed study of grammar. Practice in written and oral expression in Russian on a variety of topics. Supplementary readings to emphasize application of grammatical principles. 3105 includes a rapid grammatical review.
Prerequisite(s): RUS 2106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3114 - Accelerated Advanced Russian Grammar Conversation Composition (6 credits)
Proficiency-oriented approach to advanced Russian. Daily progression through advanced Russian grammar, conversation and composition. Accelerated development of the four language modalities (speaking, listening, reading, writing) in a cultural context. Short translations and paraphrases of authentic Russian texts. Duplicates RUS 3105 and 3106.
Prerequisite(s): RUS 2106 or RUS 2114
Instructional Contact Hours: (6 Lec, 6 Crd)

RUS 3124 - Russian for Oral Proficiency (3 credits)
Devoted to the acquisition of measured levels of proficiency in speaking and understanding spoken Russian. Content-based instruction in small groups. For students who would like to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. Admission by oral exam required. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3304 - Survey of Nineteenth-Century Russian Literature in Translation (3 credits)
Masterpieces of Russian fiction and poetry written between 1815 and 1881. Romantic poetry of the early nineteenth century and traces the beginnings of Russian prose from early short stories to the rise of the novel as the dominant literary form in the second half of the century. History and politics to theological and philosophical issues in various works. Methods, terminology and practice of literary analysis. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3314 - Survey of Twentieth-Century Russian Literature in Translation (3 credits)
Masterpieces of the twentieth-century Russian literature. Symbolist, Acmeist and Futurist poetry, modernist and postmodernist prose such as Mikhail Bulgakovs The Master and Margarita, and Viktor Pelevins Life of Insects. Terminology, practice, and standard methods of literary analysis. Interactions between major political events, social and literary movement. Aesthetic and rhetorical strategies. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 3424 - Topics in Russian Literature in English (3 credits)
Variable-content course devoted to the study of Russian literary classics. From general surveys of nineteenth- and twentieth-century literature to more intensive study of the works of a single major author. Aesthetic and rhetorical strategies. Interactions between literary movements and political, historical, and cultural events. May be repeated once with different content for a maximum of 6 credits. Readings and lectures in English. No knowledge of Russian required.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ENGL 3424

RUS 3434 - The Works of Vladimir Nabokov (3 credits)
Readings in major works of Vladimir Nabokov from the 1920s through the 1970s. Aesthetic and rhetorical strategies, literary analysis, major themes, immigration and cultural knowledge. Taught in English.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3434

RUS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4204 - Topics in Russian Culture and Civilization (3 credits)
Specific topics in Russian culture and civilization. Variable content. May be repeated for credit with different content.
Prerequisite(s): RUS 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 4304 - Studies in Russian Literature (3 credits)
Selected masterpieces of Russian literature, read in original. Lectures and discussions in Russian. May be repeated for credit with different content.
Prerequisite(s): RUS 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

RUS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RUS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (SPAN)

SPAN 1105 - Elementary Spanish (3 credits)
Fundamentals of grammar, composition, and oral skills. Readings carefully selected for comprehension and simple conversation. 1105 for students with no high school Spanish; 1106 for students who have completed 1105 or who have less than three years of high school Spanish.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 1106 - Elementary Spanish (3 credits)
Fundamentals of grammar, composition, and oral skills. Readings carefully selected for comprehension and simple conversation. 1105 for students with no high school Spanish; 1106 for students who have completed 1105 or who have less than three years of high school Spanish.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 1114 - Accelerated Elementary Spanish (4 credits)
Condenses SPAN 1105 and 1106. Proficiency-oriented approach to elementary Spanish, designed for learners with some prior experience in the language or for those who wish to progress rapidly through the beginning stages of language learning. Supplemented with a self-instructional electronic component. Meets University and college foreign language requirement. SPAN 1114 duplicates SPAN 1106.
Instructional Contact Hours: (3 Lec, 2 Lab, 4 Crd)

SPAN 2105 - Intermediate Spanish (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2106 - Intermediate Spanish (3 credits)
Review of grammar with increasing emphasis on reading, writing, and oral communication.
Prerequisite(s): SPAN 2105
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2114 - Accelerated Intermediate Spanish (6 credits)
Proficiency-oriented approach to intermediate Spanish, designed for learners who wish to progress rapidly through the intermediate stages of language learning. Review of grammar with increasing emphasis on reading, writing, listening, and oral communication. Study of authentic materials and cultural artifacts in Spanish. Study of cultures, traditions, customs, and social conventions of the Spanish-speaking world. Not recommended for native speakers of Spanish. Accelerated version of 2105-2106. Duplicates 2105-2106.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (6 Lec, 6 Crd)

SPAN 2124 - Intermediate Spanish for Building Construction (3 credits)
Proficiency-oriented approach to intermediate Spanish, designed for learners who wish to incorporate building construction topics at the intermediate stage of language learning. Review of grammar with increasing emphasis on reading, writing, listening, and oral communication applied to the field of Building Construction. Study of authentic materials related to personal and professional situations in the field of Building Construction. Development of communication strategies for risk assessment, health concerns, and basic instructions with Spanish-speaking workers in Building Construction. Duplicates Spanish 2105 Intermediate Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 1106 or SPAN 1114
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2744 - Topics in Spanish Culture (3 credits)
Examines fundamental concepts related to Spanish culture within a specific historical and geographical context. Interprets cultural artifacts of the period across selected genres, including drama, poetry, film, and/or art. Analyzes how cultural identity is constructed by multiple and diverse disciplinary perspectives and in response to global challenges and opportunities. Taught in English. Repeatable with different topics for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 2754 - Topics in Spanish American Culture (3 credits)
Examination of fundamental concepts related to Spanish American culture in variable historical and geographical contexts through the study of one or more of the following: narrative; essay; drama; poetry; film; and art. Emphasis on the interpretation and analysis of cultural texts and other creative artifacts in the context of key historical and political events, in order to understand shifting concepts of cultural identity, advantages and challenges of diversity and inclusion, and global challenges and opportunities in the human world. Taught in English. Course may be repeated, with different topics, for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 2764 - Introduction to Latino American Studies (3 credits)
Introduction to interdisciplinary field of Latino American Studies. Exploration of debates and problems of Latin American and Latina/o history and culture. Examination and analysis of transnational, social, and cultural trends. Emphasis on connections between United States and Latin America, and local and regional Latina/o communities. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2774 - Minority Languages in the Spanish-Speaking Context (3 credits)
Examination of language policies and practices with regard to minority languages across the Spanish-speaking context, histories of minority languages in Spanish-speaking areas, and the current socio-political situations of these languages and their speakers. Exploration of issues concerning linguistic rights, such as access to education, economic opportunities, and political status; analysis of the implications of restrictions on minority groups linguistic rights. Discussion of why some minority-language speakers have been more successful in their language conservation or revitalization efforts than others. Taught in English. Does not count toward the Spanish major or minor.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 3105 - Grammar, Composition and Conversation (3 credits)
3105: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish. 3106: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 2106
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3106 - Grammar, Composition and Conversation (3 credits)
3105: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish. 3106: Practice in communication skills in Spanish. Development of reading, writing, listening and speaking skills. Review and use of grammar. Comprehension of the role of culture in communicating and in understanding cultural differences. Study of authentic materials in Spanish. Not recommended for native speakers of Spanish.
Prerequisite(s): SPAN 2106
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3125 - Spanish for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken Spanish. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3126 - Spanish for Oral Proficiency (3 credits)
For acquisition of measured levels of proficiency in speaking and understanding spoken Spanish. Content-based instruction in small groups. 3125: to achieve an oral proficiency rating comparable to Intermediate-high on the American Council on the Teaching of Foreign Languages Oral Proficiency Interview (ACTFL-OPI) or S-1+ on the Foreign Service Institute (FSI) scale. 3126: to achieve an oral proficiency rating comparable to Advanced on the (ACTFL-OPI) or a 2 on the FSI scale. Admission by oral exam.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3154 - Spanish for the Natural Sciences (3 credits)
Knowledge of the Spanish language and its cultures to the natural sciences. Study of scientific materials in Spanish. Practice in communication skills through contextualized use of specific vocabulary, idiomatic expressions, grammar structures and cultural practices in real-world situations. Discussion on scientific topics and debates of the Spanish-speaking world. Comparison of the practices and world views of scientists and clinicians in Hispanic and English-speaking countries. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3224 - Topics in Latinx Culture (3 credits)
Transdisciplinary examination of fundamental concepts related to Latinx/Hispanic culture—among these, cultural hybridity, multilingualism, civil rights, activism, social justice, and marginalization—in variable cultural, historical, political, and geographical contexts. Study of one or more of the following: narrative, essay, drama, poetry, popular media and works of art. Emphasis on the interpretation and analysis of texts and other creative artifacts to understand Latinx culture's intersections with race, ethnicity, gender, sexuality, class, religion, indigeneity, nationality, disability, etc., challenges of diversity and inclusion, and the sociopolitical issues affecting those who identify as Latinx or Hispanic in the United States. Course may be repeated, with different topics, for a maximum of 6 credits. Taught in English.
Prerequisite(s): SPAN 2764 or SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 3304 - Introduction to Hispanic Literature (3 credits)
Introduction to Hispanic literary genres (poetry, narrative, essay, and drama) through analysis and discussion of the main historical, political and cultural concepts of Hispanic Literature from Spain and Latin America from the Middle Ages to the present. Identification of issues of diversity (race, gender, and social class) in the Spanish-speaking world. Methods, terminology, and practice of literary analysis. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3404 - Early Peninsular Culture and Literature (3 credits)
Examination of the culture and literature of Spain from the 9th century to the 18th century, including historical documents, narrative, poetry, theatre, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events. Examination of multiple levels of cultural identity, including advantages and challenges of diversity, found within the Iberian peninsula during that time frame. Reflection on similarities of intercultural exchange in medieval Spain and our own age. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3414 - Modern Peninsular Culture and Literature (3 credits)
Examination of the culture and literature of Spain from 1700 to the present, including narrative, poetry, theatre, film, and art. Emphasis on the interpretation and analysis of cultural texts in the context of key historical and political events, in order to understand shifting concepts of cultural identity and advantages and challenges of diversity. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3444 - Early Spanish-American Culture and Literature (3 credits)
Exploration of the cultural development of Spanish America from the pre-Hispanic era, the Encounter, the three hundred years of colonialism to Independence from Spain and nation- building in the 19th century; analysis of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, art, architecture and music; interpret intercultural experiences from ones own worldview. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3464 - Topics in Modern Mexican and Central American Cultures (3 credits)
Interdisciplinary exploration of concepts of Mexican and Central American cultures from the post-independence periods to the present. Analysis of cultural production within the historical, political, social, and intellectual contexts in which they were created. Interpretation of canonical and non-canonical texts, including historical texts, narratives, poetry, drama, film, art, architecture, and music. Analysis of current events and identification of changes brought on by globalization from an intercultural point of view. Articulation of advantages and challenges of cultural diversity. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3474 - Modern Spanish-Caribbean Culture and Literature (3 credits)
Exploration of the civilization, culture, and literature of the Spanish Carribbean, spanning the 19th century post- independence period to the present; analysis of literary and cultural texts within the historical, political, and social context in which they were created; interpretation of canonical as well as non-canonical texts, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Taught in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3484 - Modern Andean and Southern Cone Culture and Literature (3 credits)
Exploration of the civilization, culture and literature of the Andean and Southern Cone regions of South America, spanning the 19th century post-independence period to the present; examination of literary and cultural texts with the historical, political, and social context in which they were created; study of canonical as well as non-canonical texts, from both high and popular culture, including historical texts, narrative, poetry, drama, film, art, architecture, and music; analysis of current events and identification of changes brought on by globalization; articulation of the advantages and challenges of cultural diversity. Tuaght in Spanish.
Prerequisite(s): SPAN 3304
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3494 - Introduction to Hispanic Linguistics (3 credits)
Introduction to fundamental concepts of Hispanic linguistics. Examination of linguistic properties in Spanish (e.g.,morphology, syntax, and semantics/pragmatics). Exploration of context-appropriate language use. Interpret experiences with language from different perspectives. Examination of complexities of cross-cultural communication. In Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3514 - Spanish for Medical Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the medical professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats. Cross-cultural discussions on healthcare issues in the Hispanic world. Analysis of medical topics related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural and linguistic diversity in the medical professions. Analysis of political and cultural history of the Hispanic and Latino populations in the US. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3524 - Introduction to Spanish Translation (3 credits)
Introduction to the translation of various types of texts, such as literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language. Taught in Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3534 - Spanish for Business Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the business professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats such as cover letters and business memos. Discussion on cultures of business in the Hispanic world. Analysis of business topics related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural and linguistic diversity in the business professions. Analysis of economic and political history of Spanish-speaking populations. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3544 - Sounds of Spanish (3 credits)
Provides students with an overview of phonetics and phonology in Spanish and familiarizes students with the articulatory descriptions of vowels and consonants of Spanish. Compares and contrasts the sound systems of Spanish and English. Analyzes the sound system using theories and methods in linguistics. Explores the social meaning of the phonetic variation that exists throughout the Spanish-speaking world. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3554 - Teaching Spanish (3 credits)
Examination of theories and approaches to second-language and heritage-language learning and teaching. Discussion of technological resources and authentic materials that promote language teaching and individual differences that affect language learning. Analysis of pedagogical materials for the Spanish-language classroom. Hands-on experience with lesson-plan design for teaching Spanish. Taught in Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3564 - Community through Service: Latino NRV (3 credits)
A service-learning course in Spanish. Exploration of Latino cultures in the U.S.; weekly service with members of local Latino communities who have requested help; reflection on community work and student citizenship; exploration of cultural factors involved in the construction of community, including the challenges of immigration, multiculturalism, and multilingualism within the U.S.; analysis of literary readings, films, and works of art from U.S. Latino communities; discussion of readings on Hispanic migrations and border studies, as well as articles on social privilege, service-learning, education, health care, language, and language learning. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3574 - Spanish for Legal Professions (3 credits)
Specialized course applying knowledge of the Spanish language and its cultures to the legal professions. Contextualized use of specific vocabulary, idiomatic expressions, grammar structures, and cultural practices in real-world situations and written formats. Cross-cultural discussions on legal issues in the Hispanic world. Analysis of legal topics and concepts related to Spanish-speaking populations in a global context. Examination of Hispanic cultural artifacts such as film and narrative that explore issues of cultural, ethical, and linguistic diversity in the legal professions. Analysis of political and cultural history of the Hispanic and Latino populations in the US. Taught in Spanish.
Prerequisite(s): SPAN 3106
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4104 - Advanced Grammar and Style (3 credits)
Analysis of and practice with advanced grammatical and stylistic concepts, including idiomatic and colloquial usage. Intended to help advanced students achieve high levels of proficiency in writing and speaking Spanish.
Prerequisite(s): SPAN 3106
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4114 - Topics in Spanish Linguistics (3 credits)
Variable content course that surveys linguistic concepts and methods as related to the Spanish language. Topics may include the study of the phonology, morphology, syntax, and semantics of Spanish; the pedagogical application of these language systems; the psychological and social context of language; and the development of Spanish from its origins to its modern form. May be repeated for credit with different content.
Prerequisite(s): SPAN 3494 or SPAN 3544
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4124 - Spanish Translation: Theory and Technique (3 credits)
Introduction to translation theories and application of these theories to different types of texts, including literature, business correspondence, commercial advertising, and legal documents. Includes translation from English to Spanish and from Spanish to English, as well as a thorough review of Spanish grammar and idiomatic language.
Prerequisite(s): SPAN 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4304 - Topics in Early Modern Literature and Culture (3 credits)
Variable topics in Hispanic and/or Latin American literature and culture of the Early Modern period. Texts and/or cultural artifacts selected for aesthetic value, historical importance and thematic significance. Related scholarly criticism representing a variety of approaches. Emphasis on historical, social and cultural context. May be repeated twice for credit with different content. Taught in Spanish.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SPAN 4314 - Studies in 18th and 19th Century Literature (3 credits)
A variable content course devoted to Hispanic literature of the 18th and 19th centuries. The texts selected are studied not only for their aesthetic value but also in terms of their historical and cultural significance. May be taken twice for credit with different content. Taught alternate years. I
Prerequisite(s): SPAN 3414 or SPAN 3404 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4324 - Studies in 20th and 21st Century Hispanic Literature (3 credits)
A variable content course devoted to Hispanic literature of the 20th and 21st centuries. Offers an in-depth literary exploration of a significant historical period, cultural movement, theme, or genre. Focuses on literary and cultural analysis from a variety of perspectives. Practices advanced Spanish oral and writing skills. Examines texts that have aesthetic value and historical and cultural significance. May be taken up to three times for credit with different content.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 3 credit hours

SPAN 4334 - Special Topics in Hispanic Life, Literature, and Language (3 credits)
Broad central themes of Hispanic culture as manifested in creative and historical literature, music, art, film, etc., or in language, such as the history of the Spanish language, translation techniques, or the staging of dramatic works in Spanish. Historical and/or national boundaries are crossed whenever the nature of the topic permits. May be repeated for credit with different content. Taught alternate years.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)

SPAN 4344 - Hispanic Literature and the Representation of History (3 credits)
Focuses on the relationship between history and literature in the Hispanic world through an interdisciplinary lens. Examines different geographical regions of the Hispanic world, theoretical readings, and the ways that authors have used various literary styles to portray, re-write, subvert, and even contradict their countries official history. Examines texts that have aesthetic value and historical and cultural significance. Practices advanced Spanish oral and writing skills. This variable topics course may be repeated up to three times if topics are different.
Prerequisite(s): SPAN 3404 or SPAN 3414 or SPAN 3444 or SPAN 3464 or SPAN 3474 or SPAN 3484
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

SPAN 4794 - Senior Tutorial in Spanish Studies (1 credit)
Individual or small group sessions which give the student the opportunity to hone special language skills, with a focus on post-graduation application of these skills. May concentrate on areas such as technical or business language, linguistics, translation, interpreting, creative writing, specialized literary, or cultural studies. May be taken twice for credit with different content. Must be pre-arranged three weeks before end of previous semester. One 4000 level Spanish course required. Restricted to Seniors. Restricted to Spanish majors. Consent of Spanish Section required.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPAN 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4964H - Field Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

SPAN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SPAN 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Arabic Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture (or an FYE course completed in another major)	3
Language (e.g., Oral, Written, Interpretive)		
ARBC 2105	Intermediate Arabic	3
ARBC 2106	Intermediate Arabic	3
Other Language-program-specific Courses (e.g., Literature, Culture, Linguistics)		
ARBC 3105	Advanced Arabic	3
ARBC 3106	Advanced Arabic	3
ARBC 3124	Arabic for Oral Proficiency	3
ARBC 4154	Advanced Composition and Stylistics	3
Subtotal		21
Major Requirements		
ARBC 3514	Media Arabic	3
ARBC 2774	Arab Culture and Civilization [1]	3
ARBC 3474	Topics in Arab Cinema [1,2]	3
ARBC 3304	Modern Arabic Literature in Translation [1]	3
or ARBC 3274	War and Arab Culture	
ARBC 4334	Research in Arab Culture	3
Subtotal		15
Free Electives		
Complete remaining credit hours to satisfy 120 credit hour requirement.		39
Subtotal		39
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3

Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [3]	3
Subtotal	45
Total Credits	**120**

[1] May also count toward Pathways. Taught in English.
[2] May be taken twice for 6 credits.
[3] May be double-counted with another core concept.

Satisfactory Progress Toward Degree

By the time a student majoring in Arabic has completed 72 semester credits (including transfer, advanced placement, advanced standing, and course withdrawal), the student must have completed satisfactorily the following courses in Arabic: ARBC 3105 Advanced Arabic, ARBC 3106 Advanced Arabic, and ARBC 3124 Arabic for Oral Proficiency. Satisfactory completion means a C or better (in each required course in the major).

- Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements.

Graduation Requirements

GPA Requirements

Students must have a 2.0 in-major GPA in Arabic and earn a C or better in each course for it to count towards the major.

Total Hours Required: 120 credit hours required for graduation

Transfer Credit

- Students may transfer no more than 18 of the last 45 cr. of course work. Study Abroad falls under this rule if it is not VT credit.
- A form for "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the department representative, and the Director of the Global Education Office before the student departs on the study abroad program.
- A maximum of 50% of the required credits for a degree may be earned at a two-year college.

Free Electives:

- Complete remaining credit hours needed to satisfy degree 120 credit hour requirement.

Additional Graduation Requirements

As a major in Arabic, you will have completed the Foreign Language (FL) requirement at Virginia Tech:

- Students who completed 3 years of a single FL in high school have completed the requirement.
- Students who did not complete 3 years of a single FL in high school may complete the requirement as follows:
  - Complete 2 years of a single language in high school, plus 1106 or equivalent in college (these 3 hours count toward the 120 required for graduation) **or**
  - Complete 1105-1106 or equivalent in college (these 6 hours do not count toward the 120 required for graduation)

Classical Studies Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture (or another FYE class completed for another major)	3
Language (e.g., Oral, Written, Interpretive)		
Select two of the following: [1]		6
LAT 3004	Readings in Latin Literature [2]	
LAT 4004	Directed Studies in Latin Prose Composition	
Other Language-program-specific Courses (e.g. Literature, Culture, Linguistics)		
HIST 1024	Ancient History	3
CLA 2454	Topics in Ancient Greek and Latin Literature	3
ART 3084	Greek Art and Architecture	3
or ART 3184	Roman Art and Architecture	
CLA/ENGL/RLCL 2444	Ancient Greek and Roman Mythology	3
Subtotal		21
Major Requirements [3]		
Select four of the following:		12
LAT 1105	Elementary Latin	
LAT 1106	Elementary Latin	
LAT 2104	Cicero and Livy [2]	
LAT 2114	Latin Epic: Vergil and Ovid [2]	
LAT 2124	Latin Lyric: Catullus and Horace [2]	
LAT 2134	Late Medieval Latin [2]	
GR 1105	Classical and New Testament Greek	
GR 1106	Classical and New Testament Greek	
GR/RLCL 2104	Greek New Testament [2]	
GR 2114	Readings in Classical Greek Literature [2]	
Select two of the following:		6
ART 3074	Egyptian Art and Architecture	
ART 3174	Introduction to Archaeology	
CLA 1134	The Ancient Mediterranean World	
CLA 2434	Fairytale, Folklore, and Magic: Popular Literature in Ancient Greece and Rome	
CLA 2464	Mythology, Philosophy and Video Games	
CLA 3954	Study Abroad	
HIST/CLA 2224	Ancient Greek and Roman Women	
HIST/CLA 2234	Classics in the Modern World	
HIST 3274	The Greek City	
HIST 3284	The Roman Revolution	
HIST 3294	Roman Britain	

HIST 3304	The World of Alexander the Great	
HIST 3314	The Later Roman Empire	
PHIL 2115	Ancient Through Medieval Philosophy	
RLCL 2424	New Testament	
RLCL 3414	Jesus in Earliest Christianity	
RLCL 3424	Orthodoxy and Heresy in Early Christianity	
ART 3004	Topics in Art History [4]	
RLCL 4324	Topics in Religion and Culture [4]	
PHIL 4014	Special Topics in Philosophy [4]	
Subtotal		18
Free Electives		
Complete remaining credit hours to satisfy degree 120 credit hour requirement		36
Subtotal		36
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 Student may take two LAT 3004 or one of each.

2 May be repeated for credit with different content.

3 Approved courses in this section may also count toward Pathways. Some courses listed on this checksheet may have prerequisites; please consult the University Course Catalog or check with your advisor. All courses on this checksheet are three credits.

4 When the topics pertain to Classical Studies, the following courses may also be included in the Classical Studies Major. Consult your advisor for Classical Studies.

Satisfactory Progress Toward Degree

In addition to university policies regarding satisfactory progress:

1. Completion of the Curriculum for Liberal Education or Pathways appropriate for the term and year of entrance.

2. Completion of 15 hours of the major upon having completed 72 hours.

Graduation Requirements

GPA Requirements

Students must maintain a 2.0 GPA in the Classical Studies major. The in-major GPA is calculated as the GPA in all courses a student takes for the Classical Studies major. A minimum grade of C (2.0) must be earned by Classical Studies majors in all courses taken to satisfy the Classical Studies major. No course taken Pass/Fail can be included in a Classical Studies Major.

Total Hours Required

Students must complete a minimum of 120 hours in order to graduate.

Satisfactory Progress Toward Degree

In addition to university policies regarding satisfactory progress:

1. Completion of the Curriculum for Liberal Education or Pathways appropriate for the term and year of entrance.

2. Completion of 15 hours of the major upon having completed 72 hours.

Independent Study (2974 or 4974), Special Study (2984 and 4984), or Undergraduate Research (4994) in any department, including LAT or GR, may be substituted *if the topic is fitting*; consult the Classical Studies advisor. All substitutions must be approved by the Classical Studies advisor.

Acceptable Substitutions

Independent Study (2974 or 4974), Special Study (2984 and 4984), or Undergraduate Research (4994) in any department, including LAT or GR, may be substituted *if the topic is fitting*; consult the Classical Studies advisor. All substitutions must be approved by the Classical Studies advisor.

Foreign Language Requirement

High School Language Requirement: Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

French Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture	3
Language (e.g. Oral, Written, Interpretive)		
FR 3126	French for Oral Proficiency [1]	3
FR 4154	Advanced Composition and Stylistics	3
Other Language-Program-Specific Courses (e.g. Literature, Culture, Linguistics)		
FR 3304	Introduction to French Literature	3
FR 3314	Introduction to Francophone Studies	3
Select two of the following:		6
FR 4164	Special Topics in Business French [2]	
FR 4314	Studies in French Literature [2]	
FR 4324	Special Topics in French Life, Literature and Language [2]	
Subtotal		21
Major Requirements		
FR 3105	Composition, Conversation and Grammar [3]	3
FR 3106	Composition, Conversation and Grammar [3]	3
Select three of the following:		9
FR 3164	Advanced Business French	
FR 3424	French Culture from Middle Ages to Renaissance [3]	
FR 3434	French Culture from Baroque to Revolution [3]	
FR 3444	French Culture from Romanticism to Belle Epoque [3]	
FR 3454	French Culture from World Wars to Global Present [3]	
Subtotal		15
Free Electives		
Select remaning credit hours to satisfy 120 credit hour requirement		39
Subtotal		39
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select nine hours from Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) and Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		9
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select nine hours from Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) and Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		9
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six hours from Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) and Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 Most students also take FR 3125 French for Oral Proficiency.
2 May be repeated for credit with different content.
3 May also count toward Pathways.

Satisfactory Progress Toward Degree

FR 3105 Composition, Conversation and Grammar, FR 3106 Composition, Conversation and Grammar, and FR 3304 Introduction to French Literature will need to be completed satisfactorily (with a C or better in each required course in the major) by the time a student majoring in French has completed 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal).

Graduation Requirements

Total Hours Required

120 credit hours required for graduation.

GPA Requirements

Students must earn a 2.0 or better in all of the courses in the Core Degree Requirements and Major Requirements (except those offered P/F only).

Pre-/Co-Requisite

Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements.

Transfer Credit

Although students may transfer no more than 18 of the last 45 cr. of coursework a waiver may be requested for students participating in study abroad programs. A form for “Authorization to Take Courses Elsewhere” must be filled out and signed by the student, the departmental representative, and the Director of the Office of Education Abroad before the student departs on the study abroad program.

Those who are transferring to Virginia Tech from a two-year school must complete at least 50% of the required graduation credit at Virginia Tech.

Students with transfer credit for the French major must earn at least 25% from Virginia Tech.

AP and IB Credit

Please see a French advisor to inquire about the appropriate substitution for this credit.

Total Hours Required in French

Students must earn 36 credit hours for the French major regardless of initial course placement.

Satisfactory Progress Toward Degree

FR 3105 Composition, Conversation and Grammar, FR 3106 Composition, Conversation and Grammar, and FR 3304 Introduction to French Literature will need to be completed satisfactorily (with a C or better in each required course in the major) by the time a student majoring in French has completed 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal).

Foreign Language Requirement

Language Study Requirement

As a major in French, you will have completed the Foreign Language requirement at Virginia Tech

German Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture (or an FYE course completed in another major)	3
Language		
(e.g., oral, written, interpretive)		
GER 3126	German Oral Proficiency [1]	3
GER 4154	Advanced Composition and Stylistics [2]	3
Other Language-Program-Specific Courses		
(e.g., literature, culture, linguistics)		
GER 3204	Culture of the German-Speaking Countries [2]	3
GER 3xxx or GER 4xxx [3]		3
Select at least two of the following:		6
GER 4304	Age of Goethe [2]	
GER 4314	Studies in 19th-Century Literature [2,4]	
GER 4324	Studies in 20th-Century Literature [2,4]	
GER 4334	Special Topics in German Life, Literature, and Language [2,4]	
Subtotal		21
Major Requirements		
GER 3105	Grammar, Composition and Conversation [2,5]	3
GER 3106	Grammar, Composition and Conversation [2,5]	3
GER 3305	Topics in German Culture and Literature [2,6]	3
GER 3306	Topics in German Culture and Literature [2,6]	3
Subtotal		12
Free Electives		
Select remaining credit hours needed to satisfy the 120 credit hour degree requirement		42
Subtotal		42
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1. Students who do not place into or out of GER 3126 (https://catalog.vt.edu/search/?P=GER%203126) German Oral Proficiency are strongly advised to take GER 3125 (https://catalog.vt.edu/search/?P=GER%203125) German Oral Proficiency, which is designed to enable students to achieve the level of oral proficiency required for entry into GER 3126 (https://catalog.vt.edu/search/?P=GER%203126) German Oral Proficiency. For most students, the hours represented by GER 3125 (https://catalog.vt.edu/search/?P=GER%203125) German Oral Proficiency will be in addition to the minimum of 33 hours required for the major.
2. These courses required for the German major have prerequisites. Please refer to the Undergraduate Course Catalog or consult your advisor for information about prerequisites.
3. Major elective credit for GER courses taught in English (e.g., GER 3474 (https://catalog.vt.edu/search/?P=GER%203474) Topics in German Cinema) may be awarded with the approval of the instructor and the German advisor. A maximum of two such courses may be counted for major credit.
4. Variable-content courses; may be repeated for credit with different content.
5. May also count toward Pathways Area 1.
6. May also count toward Pathways Area 2.

Satisfactory Progress Toward Degree

By the time a student majoring in German has completed 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal), the student must have completed satisfactorily (a "C" or better in each required course in the major) the following courses in German: GER 3105 Grammar, Composition and Conversation or GER 3106 Grammar, Composition and Conversation, GER 3204 Culture of the German-Speaking Countries, GER 4154 Advanced Composition and Stylistics (if not offered in senior year) and one of the following: GER 3305 Topics in German Culture and Literature, GER 3306 Topics in German Culture and Literature.

Graduation Requirements

Graduation Requirements and Notes

- **Total Credit Hours Required:** 120 credit hours are required for graduation.
- **Total Overall GPA Required:** Overall GPA requirement to graduate is 2.0.
- **In-Major Credit Hours Required:** Students must earn 33 credit hours for the German major regardless of initial course placement.
- **In-Major Grade and GPA Required:** All courses listed above under “Common Degree Core” and “Major Requirements” are considered in-major courses. A minimum grade of “C” is required in each of these courses and an average of 2.0 in all in-major courses is required for graduation.
- **AP, IB, and Study Abroad Credit:** AP placement exam credit, IB diploma credit, or study abroad credit may be used to satisfy certain requirements for the major; please see your German advisor.
- **Courses not Counting towards the Major:** GER 3125 German Oral Proficiency and GER 4964 Field Study.

Transfer Credit

- Although students may transfer no more than 18 of the last 45 credits of coursework, a waiver may be requested for students participating in study abroad programs. A form for "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the departmental representative, and the Director of the Office of Education Abroad before the student departs on the study abroad program.
- Those who are transferring to Virginia Tech from a two-year school can transfer only 50% of the required graduation credits to Virginia Tech.
- Students may transfer all German credit earned abroad, but at least 25% of the German major (a minimum of 3 courses), including one of these five courses: GER 4154 Advanced Composition and Stylistics, GER 4304 Age of Goethe, GER 4314 Studies in 19th-Century Literature, GER 4324 Studies in 20th-Century Literature, and GER 4334 Special Topics in German Life, Literature, and Language, must be taken at Virginia Tech.

Satisfactory Progress Toward Degree

By the time a student majoring in German has completed 72 semester credits (including transfer, advanced placement, advanced standing, credit by examination, and course withdrawal), the student must have completed satisfactorily (a "C" or better in each required course in the major) the following courses in German: GER 3105 Grammar, Composition and Conversation or GER 3106 Grammar, Composition and Conversation, GER 3204 Culture of the German-Speaking Countries, GER 4154 Advanced Composition and Stylistics (if not offered in senior year) and one of the following: GER 3305 Topics in German Culture and Literature, GER 3306 Topics in German Culture and Literature.

Foreign Language Requirement

Language Study Requirement

As a major in German, you will have completed the Foreign Language (FL) requirement at Virginia Tech:

- Students who completed 3 years of a single FL in high school have completed the requirement.
- Students who did not complete 3 years of a single FL in high school may complete the requirement as follows:
  - Complete 2 years of a single language in high school plus GER 1106 Elementary German or equivalent in college (these 3 hours count toward the 120 required for graduation) **or**
  - Complete GER 1105 Elementary German and GER 1106 Elementary German or equivalent in college (these 6 hours do not count toward the 120 required for graduation)

Russian Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture	3
Language (e.g., Oral, Written, Interpretive)		
Select one of the following:		6
RUS 2105 & RUS 2106	Intermediate Russian and Intermediate Russian [1]	
RUS 2114	Accelerated Intermediate Russian [1]	
Other Language-program-specific Courses (e.g., Literature, Culture, Linguistics)		
RUS 3105	Grammar, Composition and Conversation [1]	3
RUS 3106	Grammar, Composition and Conversation [1]	3
RUS 3124	Russian for Oral Proficiency	3
RUS 4204	Topics in Russian Culture and Civilization [1,2]	3
Subtotal		21
Major Requirements		
RUS 4304	Studies in Russian Literature [1,2]	3
RUS 4xxx [2]		3
Select no more than three of the following (taught in English):		9
RUS 2734	Introduction to Russian Culture and Civilization [2,3]	
RUS 3304	Survey of Nineteenth-Century Russian Literature in Translation [1,3]	
RUS 3314	Survey of Twentieth-Century Russian Literature in Translation [1,3]	
RUS/ENGL 3424	Topics in Russian Literature in English [1,2,3]	
RUS/ENGL 3434	The Works of Vladimir Nabokov [1,3]	
Subtotal		15
Free Electives		

Complete remaining credit hours needed to satisfy degree 120 credit hours requirement.	39
Subtotal	39
Pathways to General Education	
Pathways Concept 1 - Discourse	
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)	3
Pathways Concept 2 - Critical Thinking in the Humanities	
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)	6
Pathways Concept 3 - Reasoning in the Social Sciences	
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double counted with another core concept)	3
Subtotal	45
Total Credits	**120**

1 Course requires pre-requisite.
2 May be repeated for credit with different content.
3 May also count toward Pathways.

Satisfactory Progress

By the time a student majoring in Russian has completed 72 semester credits (including transfer, advanced placement, advance standing, credit by examination, and course withdrawal), the student must have completed satisfactorily the following courses in Russian: RUS 3105 Grammar, Composition and Conversation, RUS 3106 Grammar, Composition and Conversation, and RUS 3304 Survey of Nineteenth-Century Russian Literature in Translation. Satisfactory completion means a C or better.

Graduation Requirements

As a major in Russian, you will have completed the Foreign Language (FL) requirement at Virginia Tech

Additional Information on Requirements

Courses for the major or Pathways cannot be taken Pass/Fail, except for RUS 3124 Russian for Oral Proficiency. Courses taken in the major may count toward meeting the Pathways requirements.

Pre-/Co-Requisite

Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements.

Transfer Credits

Students may transfer no more than 18 of the last 45 credits of coursework. Study Abroad credits fall under this rule if they are not VT-sponsored study abroad programs. At least 25% of the 120 hours required for the degree and 25% of the credit hours required for the major must be completed at VT. A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the student's Russian advisor, and the Director of the Office of Education Abroad before the student departs on the study abroad program.

- In-major courses: All of the above are considered in-major courses
- Students must earn 36 credit hours for the Russian major regardless of initial course placement.
- Students must have a 2.0 in-major GPA in Russian and earn a C or better in each course (except those offered P/F only) for it to count towards the major.

Foreign Language Requirement

As a major in Russian, you will have completed the Foreign Language (FL) requirement at Virginia Tech

Spanish Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
First Year Experience		
RLCL 1004	Introduction to Religion and Culture (or another FYE course completed for another major) [1]	3
Language (e.g., Oral, Written, Interpretive)		
SPAN 3126	Spanish for Oral Proficiency [2]	3
SPAN 3304	Introduction to Hispanic Literature [1]	3
Other Language-program-specific Courses (e.g., Literature, Culture, Linguistics)		
SPAN 3105	Grammar, Composition and Conversation [1]	3
SPAN 3106	Grammar, Composition and Conversation [1]	3
Select two of the following:		6
SPAN 4104	Advanced Grammar and Style	
SPAN 4114	Topics in Spanish Linguistics	
SPAN 4124	Spanish Translation: Theory and Technique	
SPAN 4304	Topics in Early Modern Literature and Culture	
SPAN 4314	Studies in 18th and 19th Century Literature	
SPAN 4324	Studies in 20th and 21st Century Hispanic Literature	

SPAN 4334	Special Topics in Hispanic Life, Literature, and Language	
SPAN 4344	Hispanic Literature and the Representation of History	
SPAN 4974	Independent Study [3]	
Subtotal		21
Major Requirements		
Select five courses from the following two groups		15
Group 1		
Select at least two of the following:		
SPAN 3404	Early Peninsular Culture and Literature [4]	
SPAN 3414	Topics in Modern Cultures of Spain [4]	
SPAN 3444	Topics in Early Spanish American Cultures [4]	
SPAN 3464	Topics in Modern Mexican and Central American Cultures [4]	
SPAN 3474	Topics in Modern Hispanic Caribbean Cultures [4]	
SPAN 3484	Topics in Modern Andean and Southern Cone Cultures [4]	
Group 2		
Select at least one of the following:		
SPAN 3494	Introduction to Hispanic Linguistics [4]	
SPAN 3514	Spanish for Medical Professions [4]	
SPAN 3524	Introduction to Spanish Translation	
SPAN 3534	Spanish for Business Professions [4]	
SPAN 3544	Sounds of Spanish [4]	
SPAN 3554	Teaching Spanish	
SPAN 3564	Community through Service: Latino NRV [4]	
SPAN 3574	Spanish for Legal Professions	
Subtotal		15
Free Electives		
Complete remaining credit hours needed to satisfy degree requirement of 120 credits		39
Subtotal		39
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) and three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may be double counted with another core concept)		3
Subtotal		45
Total Credits		**120**

[1] May not count toward Pathways.
[2] Requires an oral exam for admission.
[3] Requires consent of the Spanish Program for admission.
[4] May count toward Pathways.

Satisfactory Progress Toward Degree

By the time a student majoring in Spanish has completed 72 semester credits (including transfer, advanced placement, advanced standing, and course withdrawal), the student must have completed satisfactorily the following courses in Spanish: SPAN 3105 Grammar, Composition and Conversation, SPAN 3106 Grammar, Composition and Conversation, SPAN 3304 Introduction to Hispanic Literature, and one of the following: SPAN 3404 Early Peninsular Culture and Literature, SPAN 3414 Topics in Modern Cultures of Spain, SPAN 3444 Topics in Early Spanish American Cultures, SPAN 3464 Topics in Modern Mexican and Central American Cultures, SPAN 3474 Topics in Modern Hispanic Caribbean Cultures, SPAN 3484 Topics in Modern Andean and Southern Cone Cultures, SPAN 3494 Introduction to Hispanic Linguistics, SPAN 3514 Spanish for Medical Professions, SPAN 3524 Introduction to Spanish Translation, SPAN 3534 Spanish for Business Professions, SPAN 3544 Sounds of Spanish, SPAN 3554 Teaching Spanish, SPAN 3564 Community through Service: Latino NRV. Satisfactory completion means a C or better in each required course in the major.

Graduation Requirements

Additional Notes

- Total hours required: 120 credit hours required for graduation
- All courses are 3 credits.
- Free electives: Complete remaining credit hours needed to satisfy degree requirement of 120 credits.
- Students must earn 36 credit hours for the Spanish major regardless of initial course placement.
- If you have AP or IB Spanish credit, see your Spanish Advisor.
- GPA requirements: A minimum grade of "C" is required in each of these courses. A minimum overall GPA of 2.0 as well as an in-major GPA of 2.0 are required. All courses listed above are considered in-major courses.
- Priority is given to Spanish majors and minors for registration in Spanish courses.
- Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to

meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Transfer Credit

- Students may transfer no more than 18 of the last 45 credits of coursework. Study Abroad credits fall under this rule if they are not VT-sponsored study abroad programs.
- At least 25% of the 120 hours required for the degree and 25% of the required hours for the major must be completed at VT.
- A form titled "Authorization to Take Courses Elsewhere" must be filled out and signed by the student, the student's Spanish Advisor, and the Director of the Office of Education Abroad before the student departs on the study abroad program.
- A maximum of 50% of the required credits for a degree may be earned at a two-year college.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Naval ROTC

Our Website (https://liberalarts.vt.edu/rotc/navy.html)

Overview

The Naval Reserve Officers Training Corps (NROTC) offers eligible young men and women the opportunity to earn commissions in the Navy or Marine Corps. NROTC midshipmen are required to complete the naval science curriculum and attend weekly laboratory sessions. During summer vacations, midshipmen participate in active duty at-sea or shore-based training facilities for periods of approximately four weeks. Students may enroll in the NROTC Program at the start of college or at the beginning of their sophomore year. Two-, three-, and four-year scholarships may be available for those who demonstrate outstanding potential. Upon completion of university degree requirements and the naval science program, qualified midshipmen are commissioned as Ensigns in the Navy (Navy-option) or Second Lieutenants in the Marine Corps (Marine-option).

Students may join NROTC through any one of the following three programs.

Four-Year National Scholarship Program

Students enter the NROTC Four-Year Scholarship Program through a national competition as high school seniors. Students selected to receive the National NROTC Scholarship attend New Student Indoctrination (NSI) during the summer before starting at Virginia Tech. NSI is a physically demanding two-and-a-half-week indoctrination course in basic military instruction and is held at the Recruit Training Command in Great Lakes, IL.

Students must be accepted into the Virginia Tech and the Virginia Tech Corps of Cadets, as well as meeting Naval eligibility requirements, and attend the VTCC New Cadet Week before Fall classes begin. Once these requirements are met the students are appointed as Midshipmen in the Naval Reserve.

While they are enrolled and in good standing, the government provides tuition, fees, uniform allowance, book allowance, and a monthly stipend to scholarship students. Students complete Naval Science courses and participate in up to three summer training periods (known as Summer Cruise) of up to four weeks each. Upon graduation the midshipmen are commissioned with an obligation to serve on active duty for at least five years.

College Program

Students are enrolled in the College Program upon acceptance by the Professor of Naval Science. Naval Science textbooks and a partial uniform allowance are provided. Students may compete for two- and three-year scholarships as well as Advanced Standing. If accepted into Advanced Standing, juniors and seniors receive a monthly stipend in addition to naval science textbooks and a uniform allowance. Advanced Standing students are obligated to complete the prescribed naval science curriculum, attend one summer cruise training period, accept a commission in the Naval Reserve or Marine Corps Reserve upon graduation, and serve on active duty after graduation.

Two- and Three-Year NSTC Controlled Scholarship Program

Students enrolled in the NROTC College Program and in good standing may be nominated by the Commanding Officer/Professor of Naval Science for a limited number of two- and three-year scholarships awarded by the Naval Service Training Command (NSTC). If selected and found medically qualified, these students receive the same benefits and incur the same obligations as the Four-Year Scholarship Program.

Requirements for All Candidates

Qualifications for acceptable candidates for the Scholarship Programs or the College Programs include, but are not limited to: U.S. citizenship; membership in the Virginia Tech Corps of Cadets; fulfillment of physical examination requirements; and willingness to participate in required summer training periods and to qualify for and accept the appropriate commission in the Navy, Marine Corps, Naval Reserve, or Marine Corps Reserve when offered.

If not included in the requirements of their majors or the Curriculum for Liberal Education and college core curriculum, NROTC Navy-option scholarship students must complete the following: one year of college calculus through differential and integral calculus of one real variable; one year of calculus-based physics; one semester of American military affairs or national security policy; one year of English; and an Area 2 class approved by your NROTC advisor.

During NROTC enrollment, each midshipman will be required to pass semiannual physical fitness tests and to qualify as a swimmer before going on summer cruise.

Emerging Leader Scholarship Program

The University, in conjunction with the Virginia Tech Corps of Cadets Alumni Association, is offering a scholarship to incoming freshmen who are enrolled in an ROTC program and become members of the Corps of Cadets. Contact the Virginia Tech Corps of Cadets for more information.

Minor in Naval Leadership

The minor in Naval Leadership focuses on leadership development, both with regard to improving skills and personal character, with an emphasis on ethical professionalism as a warrior and national ambassador in a global context. The twelve (12) credit hours of required courses and nine (9) credit hours of elective courses are geared toward students actively seeking a commission in the United States naval services, but can also be appealing to students working in other disciplines throughout the university.

Head: Steven W. Antcliff, CAPT, USN
Professor: S.W. Antcliff
Associate Professor: M.R. Koop
Assistant Professors: W.T. Bloomer, Z.R. Crete, K.F. Davis, J.C. Graves
Professors of Practice: K.A. Ford, C.R. Stark

Undergraduate Course Descriptions (MN)

MN 1004 - Introduction to Naval Science (3 credits)
A basic introduction to the Naval profession and concept of sea power. Explores the role of the commissioned officer and covers uniform regulations, the Uniform Code of Military Justice, Naval terminology, the Oath of Office, the Navy Ethos, and customs and courtesies. Also covers basic communication and the importance of training and qualification. The relationship to sea power and maritime strategy explained through the missions of the Navy and Marine Corps, briefly touching on the mission of other branches. Explains how directives are revised and published, as well as possible threats against platforms. Basic shipboard damage control covered with an emphasis on combating naval casualties.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 1014 - Naval Fitness (1 credit)
Reflects a culture on physical fitness as way of life within the United States Navy & the United States Navy Reserve Officer Training Corps (NROTC). Structured to motivate members to participate and implement year-round physical fitness conditioning program emphasizing total-body wellness to demonstrate expeditionary mission requirements. Prepares midshipmen to demonstrate competency in fitness programs upon entering active duty. Class is limited to students currently enrolled in the Virginia Tech NROTC program. Comprised of evolving content and may be repeated 9 times for a maximum of 10 credit hours. Pre: Enrollment in the Virginia Tech Naval ROTC program.
Instructional Contact Hours: (3 Lab, 1 Crd)
Repeatability: up to 10 credit hours

MN 1104 - Naval Ships Systems I: Engineering (3 credits)
Ship characteristics and types. Includes ship design, hydrodynamic forces, stability, main propulsion, electrical and auxiliary systems, interior communications, ship control, and damage control. One semester of college level science required.
Prerequisite(s): MN 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 2004 - Naval Ships Systems II: Weapons (3 credits)
Theory and employment of naval weapons systems. Includes threat detection, evaluation, weapon selection, delivery systems, guidance, and warhead design. Elements of command, control, and communications.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 2104 - Seapower and Maritime Affairs (3 credits)
A survey of naval history from the American Revolution to the present with emphasis on major developments in strategy, tactics, and technology. Discussion of the geopolitical theory of Alfred Thayer Mahan. Explores present concerns in seapower and maritime affairs, including the economic and political dimensions of ocean commerce, the Law of the Sea, a comparison of U.S. and Soviet maritime strategies, and current naval affairs.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 3005 - Navigation and Naval Operations (3 credits)
3005: An in-depth study of the theory and practice of piloting and introduction to celestial navigation. Students develop practical skills in the use of charts, visual and electronic aids. A study of the International Rules of the Nautical Road. 3006: Relative motion, vector-analysis theory, and ship employment. Includes an introduction to naval operations, ship characteristics, shiphandling, and afloat communications. I
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 3006 - Navigation and Naval Operations (3 credits)
3005: An in-depth study of the theory and practice of piloting and celestial navigation. Students develop practical skills in the use of charts, visual and electronic aids. 3006: A study of the International Rules of the Nautical Road, relative motion, vector-analysis theory, and ship employment. Includes an introduction to naval operations, ship characteristics, shiphandling, and afloat communications. II
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 3204 - Evolution of Warfare (3 credits)
Development of warfare focusing on impact of major military theorists, strategists, and technicians. Ancient times to present. I
Prerequisite(s): MN 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4005 - Leadership and Management/Ethics (3 credits)
4005: Examines leadership skills, strategies, and contexts as interpreted through the lenses of the leader, the follower, and the situation. Contrasts the roles of leader and manager within diverse constructs. Focuses on building and sustaining high-performance teams through transformational, charismatic and servant leadership. Challenges students to develop individual leadership skill development programs. Introduces general ethical theories and moral reasoning skills in the context of ethical decision making case studies, dark side trait analysis, and associated mitigation strategies. 4006: Explores philosophical schools of ethical thought in the context of targeted/representative case studies, both historical and contemporary in nature. Applies theoretical approaches to moral reasoning specifically as they pertain to ethical dilemmas within the rubrics of distributive justice and just war theory. Analyzes moral obligations as entailed by a voluntary oath of service. Examines strategies for mentorship, behavior reinforcement, and disciplinary options to optimize organizational success. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4006 - Leadership and Management/Ethics (3 credits)
4005: Examines leadership skills, strategies, and contexts as interpreted through the lenses of the leader, the follower, and the situation. Contrasts the roles of leader and manager within diverse constructs. Focuses on building and sustaining high-performance teams through transformational, charismatic and servant leadership. Challenges students to develop individual leadership skill development programs. Introduces general ethical theories and moral reasoning skills in the context of ethical decision making case studies, dark side trait analysis, and associated mitigation strategies. 4006: Explores philosophical schools of ethical thought in the context of targeted/representative case studies, both historical and contemporary in nature. Applies theoretical approaches to moral reasoning specifically as they pertain to ethical dilemmas within the rubrics of distributive justice and just war theory. Analyzes moral obligations as entailed by a voluntary oath of service. Examines strategies for mentorship, behavior reinforcement, and disciplinary options to optimize organizational success. Pre: Sophomore Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4204 - Amphibious Warfare (3 credits)
Historical survey of the development of amphibious doctrine and the conduct of amphibious operations. Emphasis is on amphibious operations in World War II. Present day potential and limitations on amphibious operations are explored. I
Instructional Contact Hours: (3 Lec, 3 Crd)

MN 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MN 4984 - Special Study (1-19 credits)
II
Instructional Contact Hours: Variable credit course

Philosophy

Our Website (https://liberalarts.vt.edu/departments-and-schools/department-of-philosophy.html)

Overview

Courses in philosophy aim at critical understanding and rigorous evaluation of the concepts underlying our views concerning the nature of reality, what sorts of things there are, what can be known, what is of value, and what people ought to do and to aim at. The department offers both B.A. and M.A. degrees. Philosophy majors receive a strong liberal arts education and are prepared for careers that require a broad perspective and independent judgment. They are prepared for graduate work in a variety of scholarly and professional fields. An undergraduate philosophy major is especially appropriate for the student considering law school, medical school, or other professional schools. In addition, philosophy may be chosen as a minor.

Philosophy majors must complete the college core and the Curriculum for Liberal Education or Pathways. Students entering fall 2018 must complete Pathways and successfully complete at least 36 hours in philosophy, including two courses in the History of Philosophy, PHIL 3505 Modern Logic and Its Development (Symbolic Logic), two Core Analytic Philosophy courses, two Value Theory courses, and an additional 15 credit hours of philosophy courses currently offered by the Department of Philosophy. Students must take at least six Philosophy courses at the 3000-4000 level for fulfillment of the "Philosophy Major Requirements".

The department has recently added a new Philosophy, Politics, and Economics (PPE) major in Philosophy. See Philosophy Department website for specific details. A double major is possible with any of several other curricula.

Philosophy minors must complete at least 18 hours of philosophy, including one of PHIL 1504 Critical Thinking or PHIL 3505 Modern Logic and Its Development, two courses at the 3000-4000 level, an additional course from either the 3000-4000 level or in the history sequence (PHIL 2115 Ancient Through Medieval Philosophy, PHIL 2116 Ancient Through Medieval Philosophy, PHIL 2125 History of Modern Philosophy, PHIL 2126 History of Modern Philosophy), and two elective courses in Philosophy (at any level).

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree in philosophy.

- Philosophy Major (p. 1070)
- Philosophy Major with Pre-Medical Professions Option (p. 1071)
- Philosophy, Politics, and Economics Major (p. 1072)

Head: K. Trogdon
Professors: J. C. Klagge, D. Lind, L. Patton, W. Parker
Associate Professors: B. Jantzen, and K. Trogdon
Assistant Professors: M. Corredor, G. Hersch, D. Hoek, J. MacKenzie, R. Sud, and P. Yaure
Collegiate Assistant Professors: J. Horn, G. Novak
Full-time Instructor: H. Wildman Short[2]
Emeritus: R. Burian, J. Pitt, H. B. Miller, and D. Mayo

Undergraduate Course Descriptions (PHIL)

PHIL 1204 - Knowledge and Reality (3 credits)
Examines historical and contemporary approaches to such issues as: the nature of reality and the self, the relationship between mind and body, the existence of God, the nature of knowledge and illusion. Application to ethical questions about the fear of death, and the meaning of life.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1304 - Morality and Justice (3 credits)
A critical survey of theories concerning human nature, the meaningful life, and the moral evaluation of actions, persons, and institutions. Theories will be applied to such issues as abortion, justice, and moral problems faced by professionals.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1504 - Critical Thinking (3 credits)
Introduction to critical thinking, the examination of the reasons (grounds, evidence) for claims on any subject matter. Mastery of central concepts of critical thinking: argument, claim, validity and invalidity, strength and weakness, deduction and induction, fallacy, objection and response. Techniques for critical reconstruction and evaluation of arguments, including ethical ones. Formal logic techniques for evaluation of truth-functional and categorical arguments, akin to mechanical computation or derivation. Application of techniques to arguments appearing in ordinary language passages.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1604 - How Science Works (3 credits)
Introduction to scientific methods and reasoning. Foundation for interpreting scientific information and conducting research across a range of fields, especially natural sciences. Topics: use of theories, experiments and models; hypothesis testing and confirmation; deductive, inductive and abductive reasoning; descriptive and inferential statistics; causation; influence of societal values on science; diversity and objectivity in science. Examples from physics, astronomy, geology, environmental science and other fields.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 1984B - Special Study (1-19 credits)
Pathway Concept Area(s): 2 Critical Thinking Humanities
Instructional Contact Hours: Variable credit course

PHIL 2115 - Ancient Through Medieval Philosophy (3 credits)
A critical survey and analysis of the history of Western philosophical thought from its beginnings through the Medieval Period. Addresses and assesses historical theories about issues involving the nature of justice, virtue, ethics, knowledge, and reality. Key concepts analyzed include that of the soul, human flourishing, form and matter, the human function and God. 2115: Presocratics, Socrates, Plato, Aristotle, and the Stoics; 2116: late Greek and Roman philosophy, St. Augustine, St. Thomas Aquinas, and William of Ockham.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2116 - Ancient Through Medieval Philosophy (3 credits)
A critical survey and analysis of the history of Western philosophical thought from its beginnings through the Medieval Period. Addresses and assesses historical theories about issues involving the nature of justice, virtue, ethics, knowledge, and reality. Key concepts analyzed include that of the soul, human flourishing, form and matter, the human function and God. 2115: Presocratics, Socrates, Plato, Aristotle, and the Stoics; 2116: late Greek and Roman philosophy, St. Augustine, St. Thomas Aquinas, and William of Ockham.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2125 - History of Modern Philosophy (3 credits)
Philosophical thought from the seventeenth to the nineteenth century, integrating intercultural analysis and comparisons. 2125: Global traditions in 17th and 18th century natural philosophy, including theories of mind, value, and knowledge. 2126: Global traditions in 18th and 19th century philosophy, including theories of science, knowledge, and value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2126 - History of Modern Philosophy (3 credits)
Philosophical thought from the seventeenth to the nineteenth century, integrating intercultural analysis and comparisons. 2125: Global traditions in 17th and 18th century natural philosophy, including theories of mind, value, and knowledge. 2126: Global traditions in 18th and 19th century philosophy, including theories of science, knowledge, and value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2304 - Global Ethics (3 credits)
Ethical issues in international context. Application of the principles of moral theory to such issues as the obligations of richer nations toward poorer ones, cultural and other forms of relativism, emigration and immigration, nationalism, war, deterrence, intervention, environmental degradation, preservation of natural diversity, and responsibilities toward future generations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2314 - Philosophy of Sex, Gender, and Race (3 credits)
Critical survey of contemporary themes in the philosophy of race and feminist philosophy in the United States. Topics in metaphysics (what is race? what is sex? what is gender?), ethics and political philosophy (oppression, solidarity, and social justice), and epistemology (narrative, standpoint, and white ignorance). Emphasis on situating contemporary philosophical views in social and historical contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2504 - Logic and Language (3 credits)
Introduction to logic, the systematic analysis of expressions and reasoning in natural languages (like English) by means of simplified, formal languages. Foundational to philosophy, linguistics, law and computer science; useful in any discipline in the sciences or humanities where sustained reasoning and argumentation are central. Core semantic concepts: truth and meaning, synonymy, ambiguity, consistency, entailment, truth conditions. Core syntactic concepts: expression, sentence, connective, scope, predicate, term, quantifier. Core deductive reasoning concepts: argument, validity, soundness, proof. Formal languages for propositional logic and predicate logic. Translation between these formal languages and natural language sentences and arguments. Application of formal logic to evaluate natural language argumentation. Moral language and ethical reasoning.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2605 - Reason and Revolution in Science (3 credits)
Study of philosophical approaches to understanding and justifying modes of human reasoning both in science and everyday life. 2605: nature of theory confirmation and falsification; 2606: justifying changing paradigms of human inquiry.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2606 - Reason and Revolution in Science (3 credits)
Study of philosophical approaches to understanding and justifying modes of human reasoning both in science and everyday life. 2605: nature of theory confirmation and falsification; 2606: justifying changing paradigms of human inquiry.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 3015 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3015

PHIL 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3016, PSCI 3016

PHIL 3024 - Topics in Philosophical Movements (3 credits)
Focus on the assumptions, methods and ethical dimensions of one or more contemporary or historically important philosophical movement, such as Pragmatism, Feminism, Existentialism, Islamic Philosophy, Philosophy and African-American Thought, or Philosophy and Literature. May be repeated 2 times with different content for a maximum of 9 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

PHIL 3314 - Ethical Theory (3 credits)
Careful examination of some important historical or contemporary ethical theories. Includes coverage of such topics as the assessment of character and action, the foundations of ethical theories, their justification, their relationship to scientific theories, and their objective or subjective status. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3314

PHIL 3324 - Biomedical Ethics (3 credits)
Philosophical analysis of ethical issues in medicine and biotechnology, such as problems arising in connection with the relations between physicians and patients, the challenges of cultural diversity, practices surrounding human and animal research, decisions about end of life care, embryonic stem cell research, genetic engineering, biotechnological human enhancement, and social justice in relation to health-care policy.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3334 - Ethical Perspectives on Artificial Intelligence (3 credits)
Critical examination of ethical concepts and theories, such as utilitarianism, deontology and virtue theory, applied to issues that arise in artificial intelligence, including applications in smart design & construction, energy, ubiquitous mobility, and robotics & autonomous systems. Addresses questions such as: How much should privacy be protected in the digital future? How can energy be equitably transported and consumed in relation to poor regions and future generations? Who should autonomous vehicles be programmed to protect or sacrifice in emergency situations? How should we evaluate the effects on family and society of smart technology? Should we fear that robots will take over?
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3414 - Aesthetics (3 credits)
Critical survey and analysis of key concepts in aesthetics and the philosophy of art. Historical and contemporary theories concerning natural beauty, aesthetic experience and properties, the nature and interpretation of artworks, their representational and expressive features, the relationship between artistic value, the value that attaches to nature, and moral value.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3454 - Philosophy of Religion (3 credits)
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3454

PHIL 3505 - Modern Logic and Its Development (3 credits)
Logic and logical theory and the history of its development. 3505: Validity of arguments. Syllogistic logic from Aristotle to modern times. Deductive methods in truth functional and quantificational logic through the theory of identity. Translation from English into symbolic form. 3506: Metalogic and the history and philosophy of modern logical theory. Decidability and undecidability, completeness and incompleteness of formal systems. Developments from Cantor to Goedel. Must have 3505 to take 3506.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3614 - Philosophy of the Environment (3 credits)
Philosophical issues in environmental science and policy. Foundational concepts in the environmental sciences, epistemic challenges of environmental research and decision-making, and ethical questions about conservation policy and climate justice. Topics include: the wilderness ideal; biodiversity; effectiveness of different ecosystem restoration techniques; environmental modeling; decision-making under scientific uncertainty; indigenous environmental justice; ethics of de-extinction; values in environmental science; climate change; ethics of geoengineering; and public participation in conservation.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PPE 3884, PSCI 3884

PHIL 4014 - Special Topics in Philosophy (3 credits)
Critical examination of special issues or figures of current philosophical interest at an advanced level. Sample topics: Philosophy and Race; Ludwig Wittgenstein; Origins of Analytic Philosophy; and Animals, Minds and Morality. May be repeated 2 times with different content for a maximum of 9 credits. Pre: 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

PHIL 4204 - Philosophy of Mind (3 credits)
Current issues in the philosophy of mind such as relation of mind and body, status of the mental, knowledge of ones own and other minds, personal identity, consciousness, mentality of animals and machines, topics in the philosophy of psychology. 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4214 - Metaphysics (3 credits)
Critical survey and analysis of key concepts in metaphysics, the study of what kinds of entities exist and what their most fundamental and general features are like. Historical and contemporary theories concerning existence, abstract entities, material objects, time, persistence, possibility and necessity, causation, free will and determinism, and social ontology. Pre: Requires the completion of 3 credits Philosophy course.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4224 - Epistemology (3 credits)
Theory of knowledge. Is all knowledge based on experience? Does knowledge have a foundation? Can knowledge of the present and the nearby give us reasons for beliefs about the future, the past, or about events far away? 3 Philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4304 - Political Philosophy (3 credits)
Study of fundamental topics in political philosophy, such as distributive justice, equality, individual rights, constitutional government, and the justification of political authority. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 4304

PHIL 4324 - Business and Professional Ethics (3 credits)
An inquiry into the fundamental norms of conduct in business and other professions and their justification in relation to the most important ethical theories. Special attention will be given to moral problems such as the ethics of hiring and firing, bribery, and professional responsibility to society.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MGT 4324

PHIL 4334 - Jurisprudence (3 credits)
An examination of the nature of law and legal systems with attention to traditional theories of law and to such topics as judicial decision and discretion, law and morality, the justification of legal coercion. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4514 - Special Topics in Logic (3 credits)
Topics that build upon a knowledge of classical deductive logic: extensions of classical logic, alternatives to classical logic, philosophy of logic, and philosophy of language. Topics to be announced each semester course is offered.
Prerequisite(s): PHIL 3505
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4604 - Philosophy of Biology (3 credits)
This course is designed primarily for students of biology or philosophy students with a strong interest in biology. Topics vary from year to year, but include the changing character of biology as a science, the special character of biological explanations and methods, and the place and value of reduction (e.g., of Mendelian to molecular genetics) in biology.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4614 - Philosophy of Science (3 credits)
An examination of the structure and methodology of science as well as key concepts such as explanation, confirmation, realism, and instrumentalism. One year of science and 3 philosophy credits required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHIL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHIL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Philosophy Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
History of Philosophy		
Select two of the following:		6
PHIL 2115	Ancient Through Medieval Philosophy	
PHIL 2116	Ancient Through Medieval Philosophy	
PHIL 2125	History of Modern Philosophy	
PHIL 2126	History of Modern Philosophy	
Logic		
PHIL 3505	Modern Logic and Its Development	3
Metaphysics & Epistemology		
Select two of the following:		6
PHIL 1204	Knowledge and Reality	
PHIL 4204	Philosophy of Mind (3 Philosophy credits required)	
PHIL 4214	Metaphysics (3 Philosophy credits required)	
PHIL 4224	Epistemology (3 Philosophy credits required)	
PHIL 4604	Philosophy of Biology	
PHIL 4614	Philosophy of Science (3 Philosophy credits required)	
Value Theory		
Select two of the following, including at least one 3000-4000 level course.		6
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
PHIL 2314	Philosophy of Sex, Gender, and Race	
PSCI/PHIL 3015	Political Theory	
PSCI/PHIL/PPE 3016	Political Theory	
PHIL/PPE 3314	Ethical Theory (3 Philosophy credits required)	
PHIL 3334	Ethical Perspectives on Artificial Intelligence	
PHIL 3414	Aesthetics	
PHIL/PPE 4304	Political Philosophy (3 Philosophy credits required)	
Subtotal		21
Major Requirements		
Select an **additional 15 credit hours** of philosophy courses currently offered by the Department of Philosophy		15
Subtotal		15
Free Electives		
Select 39 credits of free electives		39
Subtotal		39
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select nine hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) and Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		9
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select nine hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) and Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		9
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A) and Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Integrative Learning Outcomes		
Ethical Reasoning (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)		
Intercultural and Global Awareness (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)		
Subtotal		45
Total Credits		**120**

Eligibility for continued enrollment: Checksheet requirements adhere to the "Satisfactory Progress" toward degree policy of the university (Policy 91).

Graduation Requirements

General Philosophy Major Requirements and Guidelines

1. Departmental prerequisites and corequisites for all courses must be satisfied. Please consult the University Catalog for the latest statement of these requirements.
2. Any Philosophy course taken to fulfill one of the 15 credits of Major Requirements and that has Pathways credit can be "double counted" (Pathways and Philosophy Major Requirements credit). In accordance with University Guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of degree (e.g. CLE, Pathways, etc.).
3. Students must take at least six Philosophy courses at the 3000-4000 level for fulfillment of their "Philosophy Major Requirements"

4. All courses to fulfill the "Philosophy Major Requirements" must be taken A/F and be completed with a minimum GPA of 2.0. Students must also maintain an overall GPA of 2.0.
5. A minimum of 120 semester credit hours is required for graduation.

Foreign Language Requirement

Foreign language requirement: Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Philosophy Major with Pre-Medical Professions Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
History of Philosophy		
Select two of the following:		6
PHIL 2115	Ancient Through Medieval Philosophy	
PHIL 2116	Ancient Through Medieval Philosophy	
PHIL 2125	History of Modern Philosophy	
PHIL 2126	History of Modern Philosophy	
Logic		
PHIL 3505	Modern Logic and Its Development	3
Metaphysics & Epistemology		
Select two of the following:		6
PHIL 1204	Knowledge and Reality	
PHIL 4204	Philosophy of Mind (3 Philosophy credits required)	
PHIL 4214	Metaphysics (3 Philosophy credits required)	
PHIL 4224	Epistemology (3 Philosophy credits required)	
PHIL 4604	Philosophy of Biology	
PHIL 4614	Philosophy of Science (3 Philosophy credits required)	
Value Theory		
Select two of the following, including at least one 3000-4000 level course.		6
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
PHIL 2314	Philosophy of Sex, Gender, and Race	
PSCI/PHIL 3015	Political Theory	
PSCI/PHIL/PPE 3016	Political Theory	
PHIL/PPE 3314	Ethical Theory (3 Philosophy credits required)	
PHIL 3334	Ethical Perspectives on Artificial Intelligence	
PHIL 3414	Aesthetics	
PHIL/PPE 4304	Political Philosophy (3 Philosophy credits required)	
Subtotal		21
Major Requirements		
Select an additional 15 credit hours of philosophy courses currently offered by the Department of Philosophy		15
Subtotal		15
Option Required Courses		
Pre-Medical Professions Option Required Course		
PHIL 3324	Biomedical Ethics	3
Pre-Medical Professions Option Philosophy Electives		
Select two of the following: that have not been counted towards the Philosophy Degree Core Courses Requirements:		6
PHIL 2304	Global Ethics	
PHIL 3314	Ethical Theory	
PHIL 4304	Political Philosophy	
PHIL 4604	Philosophy of Biology	
PHIL 4614	Philosophy of Science	
Pre-Medical Professions Option Non-Philosophy Electives		
Select two of the following:		6
ADV 4324	Issues in Health Communication	
ENGL 3154	Literature, Medicine, and Culture	
ENGL 3534	Literature and the Environment	
ENGL/STS 4314	Narrative Medicine	
GEOG 4074	Medical Geography of Infectious Diseases	
HIST 3624	Health and Illness in African History	
HIST 3714	War and Medicine	
HIST 3724	History of Disease, Medicine, and Health	
HD 2014	Integrative Practices for Health, Wellbeing, and Resilience	
HD 3114	Issues in Aging	
NEUR 2464	Neuroscience and Society	
PHS 2004	Introduction to Public Health	
PHS 3014	Introduction to Environmental Health	
PHS 3534	Drug Education	
PHS/HNFE 3634	Epidemiologic Concepts of Health and Disease	
PHS 4014	Public Health Program Planning and Evaluation	
PHS 4044	Public Health Policy and Administration	
PSYC 3054	Health Psychology	
SOC 3714	Sociology of Aging	
SOC 4414	Drugs and Society	
SOC 4704	Medical Sociology	
SOC 4714	Sociology of Mental Illness	
STS 2154	The Life Sciences and Society	
STS 3284	Technology and Disability	
STS 3314	Medical Dilemmas and Human Experience	
WGS/STS 4334	Sexual Medicine	
Subtotal		15
Free Electives		
Select 24 credits of Free Electives		24
Subtotal		24
Pathways to General Education		
Pathways Concept 1 - Discourse		

Select nine hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) and Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)	9
Pathways Concept 2 - Critical Thinking in the Humanities	
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)	6
Pathways Concept 3 - Reasoning in the Social Sciences	
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select nine hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) and Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	9
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select six hours in #PATHWY-6A or Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Integrative Learning Outcomes	
Ethical Reasoning (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)	
Intercultural and Global Awareness (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)	
Subtotal	45
Total Credits	**120**

Eligibility for continued enrollment: Checksheet requirements adhere to the "Satisfactory Progress" toward degree policy of the university (Policy 91).

Graduation Requirements

Major in Philosophy/ Pre-Medical Professions Option Requirements and Guidelines

1. Departmental prerequisites and corequisites for all courses must be satisfied. Please consult the University Catalog for the latest statement of these requirements.
2. Any Philosophy course taken to fulfill one of the 15 credits of Major Requirements and that has Pathways credit can be "double counted" (Pathways and Philosophy Major Requirements credit). In accordance with University Guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of degree (e.g. CLE, Pathways, etc.).
3. Students must take at least six courses at the 3000-4000 level for fulfillment of their "Philosophy Major Requirements"
4. All courses to fulfill the "Philosophy Major Requirements" must be taken A/F and be completed with a minimum GPA of 2.0. Students must also maintain an overall GPA of 2.0.
5. A minimum of 120 semester credit hours is required for graduation.

Foreign Language Requirement

Foreign language requirement: Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Philosophy, Politics, and Economics Major

Our Website (https://ppe.liberalarts.vt.edu/)

Head: Michael Moehler
Professor: M. Moehler
Associate Professor: G. Hersch
Assistant Professors: D. Gibbs, M. Miller, F. Wendt

PPE Student Advisor: H. Furrow
Undergraduate Coordinator: H. Belcher

The Kellogg Center for Philosophy, Politics, and Economics (PPE) oversees two highly interdisciplinary, research-driven undergraduate degree programs, a major and minor in PPE. The degree programs provide students with the tools, methods, and knowledge to develop comprehensive solutions to complex interdisciplinary decision-making problems, solutions that are not only economically sound, but also socially, ethically, and politically informed. The degree programs prepare students to become leaders in the fast-changing and complex social world of the 21st century.

Due to its analytical rigor, combination of normative and empirical analyses, and emphasis on the development of transferable skills, PPE prepares students for a wide variety of careers in the private and public sectors. PPE graduates have successful careers in management, marketing, consulting, industry, investment banking, finance, business administration, law, journalism, government, public administration, public policy, think tanks, health care, international affairs, international development, and non-profit organizations. In addition, PPE prepares students exceptionally well for academic programs, especially for law school, medical school, business school, and master's and doctoral programs in philosophy, political science, and economics, as well as related social sciences.

To enrich its undergraduate curriculum and allow students to develop professional skills, the Kellogg Center organizes research-focused events (https://ppe.liberalarts.vt.edu/events/), in particular a research speaker series, research fellow panels, conferences, workshops, and public lectures. In addition, it offers student-centered events and activities (https://ppe.liberalarts.vt.edu/student-involvement/), such as an undergraduate journal, reading groups, discussion colloquia, and a PPE Club. The Center's programming fosters dialogue among faculty, students, and the public and supports the integration of research and teaching.

Degree Requirements

The graduation requirements in effect during the academic year of admission to Virginia Tech apply. Requirements for graduation are listed on checksheets. Students must satisfactorily complete all requirements and university obligations for degree completion. The university reserves the right to modify requirements in a degree program.

Please visit the University Registrar's website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html for degree requirements.

Major in Philosophy, Politics, and Economics (PPE)

The PPE major allows students to study systematically some of the most important social, ethical, economic, and political problems that our contemporary societies face. It offers a highly interdisciplinary curriculum with distinct learning outcomes centered on an undergraduate research project. The PPE major is structured around four central integration courses and an optional complementary internship course:

1. The PPE First-Year Experience Course (PPE 1004) introduces students to important classic and contemporary texts in PPE. The course acquaints students with basic principles of research and writing as well as helps students to adjust to university life.

2. The PPE Gateway Course (PPE 2894) integrates the quantitative techniques, conceptual tools, and core principles of philosophy, political science, and economics.

3. Led by a faculty expert, the PPE Topics Course (PPE 3884) allows students to discuss an interdisciplinary topic in PPE in depth.

4. The PPE Capstone Course (PPE 4884) allows students to work on an advanced research project of their choice at the intersection of philosophy, politics, and economics and its application to the real world.

Minor in Philosophy, Politics, and Economics (PPE)

The PPE minor trains students to apply knowledge in the humanities and social sciences to related fields, and thus to examine the world from multiple perspectives and integrate knowledge across disciplines. The PPE minor requires 18 credit hours to be obtained from the PPE Gateway Course, the PPE Capstone Course, and four elective courses that include one applied area course. The PPE minor is an approved as a Pathways minor (https://www.pathways.prov.vt.edu/minors/showcase/ppe.html) at Virginia Tech. Relatedly, it is worth stressing that Virginia Tech is currently the only top engineering school that integrates engineering courses into its PPE curriculum. The PPE minor allows engineering students to create synergies between their engineering studies (https://enge.vt.edu/undergraduate/explore_engineering.html) and the humanities and social sciences.

Study Abroad

The Kellogg Center encourages students to participate in study abroad programs as part of their educational experience. PPE students have recently studied in continental Europe and the U.K., among other places. In general, if coordinated in advance, coursework completed abroad can count towards the PPE major and PPE minor.

The Kellogg Center has also established an international partnership with the PPE Program (https://www.ppe.hhu.de/en/) at the Heinrich Heine University Düsseldorf (HHU) in Germany. The partnership allows selected PPE students at Virginia Tech to spend a semester abroad, taking courses in PPE and related departments at HHU while exploring Europe. The courses will contribute to students' PPE degree programs at Virginia Tech.

For further details, please refer to the program description, including application details, on the Global Education Office (https://sa.globaleducation.vt.edu/?FuseAction=Programs.ViewProgramAngular&id=12496) website. The application cycle for the spring semester for the following year opens in mid-March.

To learn more, go to the Virginia Tech's German Program website (https://liberalarts.vt.edu/departments-and-schools/department-of-modern-and-classical-languages-and-literatures/academic-programs/german-major.html) or contact Dr. Esther Bauer (https://liberalarts.vt.edu/departments-and-schools/department-of-modern-and-classical-languages-and-literatures/faculty/esther-bauer.html). Please see also here for a program flyer (https://ppe.liberalarts.vt.edu/wp-content/uploads/2024/04/German-Program.pdf).

Experiential Learning

Internships and related paraprofessional activities can serve as valuable opportunities for students to apply and further engage with the skills and concepts they acquire in the classroom. They also serve as means to gain valuable professional experience, which may be particularly useful to students when pursuing career opportunities or graduate study. Please work closely with your advisor to discuss possibilities.

Participating in Virginia Tech's Bridge Experience (https://teaching.vt.edu/bridgeexperiences1.html) initiative, the Kellogg Center provides students the opportunity to enroll in PPE 3900, a 0-credit hour, self-selected, and Center approved experiential learning opportunity aligned with post-graduation goals using research-based learning processes often in the form of undergraduate research, internships, study abroad, co-ops, and other place-based experiences in the context of their PPE degree program.

The Kellogg Center also offers students the possibility to receive credit for internships, field studies, and practicums in the context of the PPE 4964 Field Work/Practicum course. Before considering this option, students should have completed PPE 2894 PPE Gateway Course. For more information concerning experiential learning opportunities offered by the Kellogg Center, please reach out to the internship coordinator Holly Belcher (hollymb2@vt.edu).

Advising

The Kellogg Center's faculty and staff work closely with students to provide a personalized learning experience. However, before you speak with PPE advising personnel, please read carefully the PPE Student Handbook (https://ppe.liberalarts.vt.edu/student-handbook/) that provides a detailed overview of the PPE degree programs and other relevant student information, including information about degree requirements, study abroad, internships, PPE events, careers and placement, and professional opportunities.

For **all PPE advising** matters, including setting up an advising appointment, please contact: Heath Furrow (hafurrow@vt.edu)

For **general questions** concerning the PPE undergraduate degree programs, please contact Holly Belcher (hollymb2@vt.edu).

Code	Title	Credits
Degree Core Requirements		
A. History of Philosophy		
Select two of the following:		6
PHIL 2115	Ancient Through Medieval Philosophy	
PHIL 2116	Ancient Through Medieval Philosophy	
PHIL 2125	History of Modern Philosophy	
PHIL 2126	History of Modern Philosophy	
B. Logic		
PHIL 3505	Modern Logic and Its Development	3
C. Metaphysics and Epistemology		
Select two of the following:		6
PHIL 1204	Knowledge and Reality	
PHIL 4204	Philosophy of Mind (3 Philosophy credits required)	
PHIL 4214	Metaphysics (3 Philosophy credits required)	
PHIL 4224	Epistemology (3 Philosophy credits required)	
PHIL 4604	Philosophy of Biology	
PHIL 4614	Philosophy of Science (3 Philosophy credits required)	
D. Value Theory		
Select two of the following, including at least one 3000-4000 level course.		6
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
PHIL 2314	Philosophy of Sex, Gender, and Race	
PSCI/PHIL 3015	Political Theory	
PSCI/PHIL/ PPE 3016	Political Theory	
PHIL/PPE 3314	Ethical Theory (3 Philosophy credits required)	
PHIL 3334	Ethical Perspectives on Artificial Intelligence	
PHIL 3414	Aesthetics	
PHIL/PPE 4304	Political Philosophy (3 Philosophy credits required)	
Subtotal		21
Major Requirements		
A. Integration		
PPE 1004	Introduction to Philosophy, Politics, and Economics	3
PPE 2894	PPE Gateway Course	3
PPE 4884	PPE Capstone Course	3
B. Concentration in Political Science and Economics		
Select 18 credit hours, 9 credit hours from each area, at least four courses at the 3000-4000 level. [1]		18
C. Free Electives		
Select up to 39 credit hours to complete 120 credit hours required for graduation. [2]		39
Subtotal		66
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select 9 hours in Pathways Concept 1 - Discourse		
Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		
PPE 4884	PPE Capstone Course	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		
PPE 1004	Introduction to Philosophy, Politics, and Economics	
PPE 2894	PPE Gateway Course (PW 2 -or- PW 3 approved)	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
PPE 2894	PPE Gateway Course (PW 2 -or- PW 3 approved)	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select 9 hours in Pathways Concept 5		
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 hours in Pathways Concept 6 - Critique and Practice in Design and the Arts		
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select 3 hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		
PPE 1004	Introduction to Philosophy, Politics, and Economics	
Integrative Learning Outcomes		
Ethical Reasoning (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)		
Intercultural and Global Awareness (This learning outcome can be combined with other Pathways courses and requires no additional credit hours)		
Subtotal		33
Total Credits		**120**

Concentration in Political Science and Economics

Select 18 credit hours, 9 credit hours from each area, at least four courses at the 3000-4000 level.

Code	Title	Credits
Political Science		
PSCI 1014	Introduction to United States Government and Politics	3
or PSCI 1014H	Honors Introduction to United States Government and Politics	
or PSCI 2014	Introduction to Political Theory	
PSCI/PPE 2024	Research Methods in Political Science	3
PSCI/GEOG/IS 2064	The Global Economy and World Politics	3
PSCI/PHIL 3015	Political Theory	3
PSCI/PHIL/PPE 3016	Political Theory	3
PSCI/IS 3144	Global Governance and Public Policy	3
PSCI/IS 3154	Topics in Global Public Policies	3
PSCI/IS 3164	Global Trade: Structures and Policies	3
PSCI/IS 3174	Monetary Foundations of the World Economy	3
PSCI/IS 3175	Global Development	3
PSCI/IS 3176	Global Development	3
PSCI 3234	Voting and Elections	3
PSCI 3334	Judicial Process	3
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
PSCI 3354	Constitutional Law: Structures and Relationships	3
PSCI 3364	Constitutional Law: Civil and Political Rights	3
PSCI 3554	Comparative Political Economy	3
PSCI/IS 3634	Human Rights: Global Issues	3
PSCI 3724	Poverty and Welfare Policy	3
PSCI/UAP 3744	Public Policy Analysis	3
PSCI 3764	Contemporary Democratic Theory	3
PSCI/UAP 3774	Marxian Political Analysis	3
PSCI/IS 4054	Seminar in Global Political Economy	3
PSCI/IS 4064	Seminar in Global Development	3
PSCI 4214	Senior Seminar in Political Behavior	3
PSCI 4314	Senior Seminar in Political Institutions	3
PSCI 4324	Senior Seminar in Constitutional Law	3
PSCI/IS 4714	Senior Seminar in Policy Analysis	3
PSCI 4724	Senior Seminar in Political Theory	3
PPE/PHIL/PSCI/ ECON 3884	Topics in Philosophy, Politics, and Economics	3
PPE 4964: FIELD W PRACTICUM		3
Economics		
ECON 1204	Economics of Race	3
ECON/PPE 1214	Economic History of Diversity and Inclusion	3
ECON 2005	Principles of Economics (micro)	3
or ECON 2025H	Honors Principles of Economics	
ECON 2006	Principles of Economics (macro)	3
or ECON 2026H	Honors Principles of Economics	
ECON 3004	Contemporary Economic Issues	3
ECON/PPE 3024	Economic Justice	3
ECON 3034	Economics of Poverty and Discrimination	3
ECON 3104	Microeconomic Theory	3
ECON/BDS 3134	Choice and Behavior	3
ECON 3144	Economics of Regulation	3
ECON 3204	Macroeconomic Theory	3
ECON 3214	Money and Banking	3
ECON 3254	Applied Econometrics	3
ECON 4014	Environmental Economics	3
ECON 4044	Public Economics	3
ECON 4054	Public Finance	3
ECON 4074	Labor Economics	3
ECON 4124	Growth and Development	3
AAEC/ECON 4135	International Economics	3
ECON 4214	Economics of Health Care	3
ECON 4424	The Theory of Games and Economic Behavior	3
ECON 4434	Experimental Economics	3
ECON/NEUR/ PSYC 4454	Neuroeconomics	3
ECON 4894	Law and Economics	3
PPE/PHIL/PSCI/ ECON 3884	Topics in Philosophy, Politics, and Economics	3
PPE 4964	Field Work/Practicum	1-19

[1] See list of approved electives.

[2] Note that PPE 1004 Introduction to Philosophy, Politics, and Economics, PPE 2894 PPE Gateway Course, and PPE 4884 PPE Capstone Course fulfill Pathways requirements and may double count towards Major Requirements. Transfer credits may reduce the number of elective credit hours depending on the total number of transfer credits awarded.

Eligibility for continued enrollment: Program requirements adhere to the “Satisfactory Progress” toward degree policy of the university (Policy 91).

Graduation Requirements

General PPE Major Requirements and Guidelines

1. Departmental prerequisites and corequisites for all courses must be satisfied. Please consult the University Catalog for the latest statement of these requirements.
2. In accordance with University Guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of degree (e.g. Pathways).
3. No more than 50% of the graded course credits required for the PPE Major may be double-counted by a student also enrolled in a Philosophy, Political Science, or Economics major.
4. All courses to fulfill the PPE major requirements must be taken A/F and be completed with a minimum GPA of 2.0. Students must also maintain an overall GPA of 2.0.
5. A minimum of 120 semester credit hours is required for graduation.

Foreign Language Requirement

Foreign language requirement: Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses

taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Undergraduate Course Descriptions (PPE)

PPE 1004 - Introduction to Philosophy, Politics, and Economics (3 credits)
Discussion of classic and contemporary texts in philosophy, politics, and economics (PPE) with historical and current relevance. Core concepts, ideas, and topics include: history of moral, political, and economic thought; political economy; justice, equality, fairness, and democracy; socioeconomic status, power, class, and diversity; the human condition and its cultural evolution and experience in the United States and abroad. Course introduces students to basic principles of research and writing. First-Year Experience course.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 1214 - Economic History of Diversity and Inclusion (3 credits)
Economic analysis of topics concerning diversity and inclusion. Emphasis on Virginia and surrounding states. Introduction to the basic principles of economic analysis and economic history, with a special emphasis on models of institutional change, economic growth, discrimination, inequality, migration, and indigenous economic systems. Impact of institutions, environment, and technological change on labor markets, asset markets, and standard of living. Consideration of the role of data in understanding diversity and related ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 1214

PPE 2024 - Research Methods in Political Science (3 credits)
Introduction to research in political science; formulation of theory, operationalization and measurement, gathering, analysis and interpretation of data.
Prerequisite(s): (PSCI 1014 or PSCI 1014H) and (PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 2024

PPE 2894 - PPE Gateway Course (3 credits)
Integrated study of philosophy, politics, and economics. Trains students to make decisions that are not only economically sound, but also socially, ethically, and politically informed. Core concepts, topics, and ideas include: models of human nature, rational choice theory, social cooperation, distributive justice, markets, and democracy. Pre: Sophomore standing.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3016, PSCI 3016

PPE 3024 - Economic Justice (3 credits)
This course explores how different assumptions regarding the basis of claims for access to economic resources lead to different outcomes. Students will explore a variety of theories and examine their own beliefs about economic justice.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3024

PPE 3314 - Ethical Theory (3 credits)
Careful examination of some important historical or contemporary ethical theories. Includes coverage of such topics as the assessment of character and action, the foundations of ethical theories, their justification, their relationship to scientific theories, and their objective or subjective status. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3314

PPE 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PHIL 3884, PSCI 3884

PPE 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

PPE 4304 - Political Philosophy (3 credits)
Study of fundamental topics in political philosophy, such as distributive justice, equality, individual rights, constitutional government, and the justification of political authority. 3 Philosophy credits required.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 4304

PPE 4884 - PPE Capstone Course (3 credits)
Discussion of advanced concepts, methods, and ideas at the intersection of philosophy, politics, and economics. Focus on utility theory, game theory, social choice theory, public choice theory, markets, justice, and democracy. Senior research project. Senior standing required.
Prerequisite(s): PPE 2894 or PHIL 2894 or PSCI 2894 or ECON 2894
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PPE 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PPE 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Political Science

Our Website (http://www.psci.vt.edu)

Overview

The department offers courses leading to degrees in Political Science and International Studies. These courses provide understanding of political systems, forms of government, international relations and other political processes throughout the world. Political science courses also offer preparation for careers in government, business, nonprofit/ nongovernemnt organizations, law, politics, and education.

General Option for the B.A. Degree

The general option encourages students to take courses in all of the subfields of political science, including political theory, comparative politics and government, U.S. politics and government, international relations, and research methodologies and methods. This permits students to describe, analyze, and evaluate governments, public policies, and political processes, systems, and behaviors, locally, nationally and globally. Students choosing this option pursue careers in government, nongovernmental organizations, business, education, law, policy analysis, and politics.

Legal Studies Option for the (LS) B.A. Degree

The Legal Studies option allows students to explore values, ideas, and reasoning linked to public law, its design, and its impact, preparing them for law school, graduate work in public policy fields, and a range of endeavors in and outside of governments. The option is not intended to be a pre-law program, although students hoping to attend law school may enroll for the option and may well benefit from its achievement.

National Security Option (NSEC) for the B.A. Degree

This option is intended to help students understand policy making in relation to the national security of the United States. Students are directed toward courses in foreign and military policy and the presidential and congressional branches of U.S. government.

Social and Political Justice (SPJ) Option for the B. A. Degree

This option allows students to think critically about rights, inequality, justice, interests, and exploitation. Students link courses in political theory, public policy, and politics to social justice in government, corporate, and civil society settings.

Applied Public Policy Studies (APPS) Option for the B. A. Degree

This option allows students to engage in more vocationally-labelled training in Political Science with an emphasis on policy studies. Students can apply their knowledge and skills to jobs in different government agencies as well as in graduate programs in Political Science, Public Administration and Policy, Public and International Affairs, or law.

Minors

The requirements to earn a minor in Political Science, International Studies, International Public Policy, International Relations, National Security and Foreign Affairs, Global Engagement, or Integrated Security can be found on the specific checksheets available on the University Registrar's website.

Regarding Double Majors

The Department of Political Science offers majors in Political Science, International Studies, International Relations, International Public Policy, and National Security and Foreign Affairs. Courses for the majors overlap significantly. Therefore, students majoring in Political Science may not double major in International Studies, International Relations, International Public Policy, or National Security and Foreign Affairs.

Advising

The department provides advisors to help students understand and meet degree requirements. Career counseling also is available in the department, as is advising for students interested in attending graduate or law school after graduation from Virginia Tech.

Internships

The department arranges academic credit for internships in state, local, and federal governments, nonprofit organizations, and other appropriate settings. The department's internship program offers students a chance to gain career-related experience in a wide variety of organizations. Information on these opportunities can be obtained from the internship director.

Student Organizations

To provide opportunities for informal association of faculty and students, the department sponsors the Political Science Club; a chapter of Phi Alpha Delta, the pre-law honor society; a chapter of Pi Sigma Alpha, the national honor society in political science; the International Relations

Organization, and other student organizations such as Model United Nations. Information about these activities, as well as about any other aspect of the department, may be obtained from the department chair, advisors, or the department office.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Curriculum for Liberal Education (see Academics chapter in this catalog), toward the department's general education requirements, and toward the degree in Political Science.

Satisfactory progress toward the B.A. in political science requires completion of PSCI 1014 Introduction to United States Government and Politics, PSCI 1024 Introduction to Comparative Government and Politics, and PSCI 2024 Research Methods in Political Science within the first 60 credit hours attempted. Students must also maintain an in-major GPA of 2.0 and must achieve a minimum grade of C in both PSCI 1014 Introduction to United States Government and Politics and PSCI 1024 Introduction to Comparative Government and Politics.

Study Abroad

Virginia Tech offers a variety of study abroad programs.

Honors

Departmental Honors Courses are occasionally offered by the Political Science Department. Political Science majors are encouraged to apply for the Honors College if they meet Honors College application eligibility requirements. Visit www.honorscollege.vt.edu (http://www.honorscollege.vt.edu) for more information.

- Applied Public Policy Studies Major Option (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/political-science/applied-public-policy-studies/)
- Political Science Major (p. 1090)
- Political Science Major with Legal Studies Option (p. 1092)
- Political Science Major with National Security Studies Option (p. 1093)
- Political Science Major with Social and Political Justice Option (p. 1095)

Chair: Timothy W. Luke
University Distinguished Professor: T. W. Luke
Edward S. Diggs Professor in the Social Sciences: E. Weisband
Professors: F. Debrix, K. M. Hult, F. Jalalzai, B. Koch, M. Moehler, I. Stivachtis, and L. Zanotti
Associate Professors: P. C. Avey, A. F. Brantly, M. Caraccioli, C. Daggett, P. Dixit, C. E. Jewitt, K. E. Kitchens, D. J. Milly, W. D. Moore, S. G. Nelson, B. Pula, and A. J. Scerri
Assistant Professors: B. S. Binev, L. Frost, D. A. Gibbs, B. Gill, N. Goedert, D. Poets, A. Reeves, C. Suong, and F. Wendt
Collegiate Assistant Professors: B. S. Faulkner and C. I. P. Thomas
Academic and Professional Faculty: C. A. Hankinson and J. A. Hanratty
Emeritus Faculty: R.C. Rich, R.D. Shingles, C.L. Taylor, and C.E. Walcott
Postdoctoral Associate: B. Barros
Internship Directors: C. I. P. Thomas (231-2855)

Undergraduate Course Descriptions (PSCI)

PSCI 1XXX3 - GEN ED REASONING SOCIAL SCI (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

PSCI 1004 - Nations and Nationalities (3 credits)
Introduction to world and American ethnic and indigenous cultures and to social constructions of human and group identity, nationalism and extreme ethno-nationalism. History of the political, economic, and cultural transition from primordial communities to sovereign states. Introduction to the rise of racism, sexism, ethnicism, classism, nativism, xenophobia, etc. in modern societies and episodes of mass political violence including ethnic cleansing and genocide.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1004

PSCI 1014 - Introduction to United States Government and Politics (3 credits)
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1014H - Honors Introduction to United States Government and Politics (3 credits)
Introduction to government and politics of the United States, the Constitution, and various institutional designs and structures. Focus on political culture, interest groups, voting franchise, political parties, and elections. Roles and responsibilities of Congress, bureaucracy, Presidency, and federal courts; Discussion of selected current policy issues and implications of diversity of elected representatives.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1024 - Introduction to Comparative Government and Politics (3 credits)
Government and politics of selected countries in the world: the necessity for government; the nature of politics and governmental systems; specific types of political systems; the effects and consequences of institutional designs; linkages of people and governments through political parties, interest groups, and social movements; current political issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1024

PSCI 1024H - Honors Introduction to Comparative Government and Politics (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 1034 - Introduction to International Studies and Political Science (3 credits)
Introduces students to the fields of International Studies and Political Science and their respective subfields. Familiarizes students with the undergraduate programs in International Studies and Political Science and emphasizes student preparation for careers in the respective fields. Focuses on inquiry, problem-solving, and integration of ideas and experiences with a focus on International Studies and Political Science. Familiarizes students with the basic principles of the research and writing principles.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1034

PSCI 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, RLCL 1084, SOC 1084

PSCI 1114 - Introduction to Transatlantic Studies (3 credits)
Multidisciplinary analysis of core issues and topics in transatlantic studies. Origins and evolution of transatlantic interactions. Historical, political, economic, cultural (including language and literature), civilizational, religious, and societal ties binding Europe and the Americas. Basic research techniques and evaluation of sources.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 1114

PSCI 1204 - Topics in Global Dialogues (1 credit)
Examination of the impact of culture in world politics. Topics under examination include: culture and global diversity; culture, identity, and order in world politics; international conflict and intercultural relations. Extensive use of case studies. May be repeated twice with different content for a maximum of three (3) credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours
Course Crosslist: IS 1204

PSCI 2014 - Introduction to Political Theory (3 credits)
Examines central themes involved in the practices of normative political theory. Topics will include critical review of the historical origins, established traditions, and major themes in normative political thinking.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 2024 - Research Methods in Political Science (3 credits)
Introduction to research in political science; formulation of theory, operationalization and measurement, gathering, analysis and interpretation of data.
Prerequisite(s): (PSCI 1014 or PSCI 1014H) and (PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 2024

PSCI 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2034, IS 2034

PSCI 2044 - Food, War and Conflict (3 credits)
Explores the history of food production and processing relative to the commencement or continuation of conflict. Examines why and how wars have been fought over economic policies, food trade and control of food supplies. Examines efforts to protect food and water supplies from intentional contamination and acts of terrorism. Focus on food products and the preservation, processing and distribution technologies that arose from war and conflict.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FST 2044, IS 2044

PSCI 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2054, IS 2054

PSCI 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2064, IS 2064

PSCI 2074 - Law and Politics (3 credits)
Explores the roles of law and legal institutions within the United States. Focuses on structures and procedures of government from a constitutional perspective; the politics of law-making and law-enforcement by legislative, executive, and judicial institutions; and relationships between law and society.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 2084 - The Evolution of World Order (3 credits)
A historical and comparative study of states systems (i.e, ancient, medieval, modern, and contemporary states system). Emphasis on the globalization of the European states system, its various aspects (political, economic, cultural, religious, civilizational, and technological) and its implications for contemporary world order (i.e., the question of human equality and the impact of colonialism and post-colonialism on the question of social, political, and economic justice).
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2084

PSCI 2104 - Europe Country Analysis (3 credits)
Examination of the politics, economics, culture, society, population patterns, and history of individual European countries. Impact of individual European states' domestic affairs on their respective European sub-regions and Europe as a whole. Analysis of intra-European regional developments. Examination of differing country perspectives on European integration.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2104

PSCI 2114 - Transatlantic Political Frameworks (3 credits)
Examination of transatlantic political, security and economic institutions, such as the Organization for Economic Cooperation & Development (OECD), the North Atlantic Treaty Organization (NATO), and the Organization for Security & Cooperation in Europe (OSCE). Impact of domestic politics and external policies on the operation of transatlantic institutions. US-European relations and their impact on transatlantic institutions and European security. Bilateral political links between European and North America States (i.e., the UK-US- Canada, and France-Canada) and their impact on transatlantic relations and European security.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2114

PSCI 2134 - Geog of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2134, IS 2134

PSCI 2164 - Foundations of Contemporary Security Environments (3 credits)
Introduction to multiple analytical perspectives on contemporary security environments, including political, legal, ethical, technical, environmental and historical and cultural perspectives relative to the conception, design and implementation of security solutions, practices, and policies. Emphasizes applying and analyzing the effectiveness of diverse procedures, tools and policies used in security and privacy solutions, decision-making, risk management and operational policy to mitigate local, national, international and global threats.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 2164, CS 2164

PSCI 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2224, IS 2224

PSCI 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2484, RLCL 2484

PSCI 2954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

PSCI 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 3004 - Professionalism and Careers in Political Science and International Studies (3 credits)
Designed to teach students how to synthesize skills and information learned in their Political Science and International Studies classes. Exploration of various career options, graduate school options, and proper procedures for seeking and applying for employment and graduate school. Introduction to professionalism in the workplace and professional development in the area of political science and international studies. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3004

PSCI 3015 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3015

PSCI 3016 - Political Theory (3 credits)
Analysis of the fundamental ideas in the history of political theory. 3015: The thought and ethical implications of philosophers from the ancient Greeks to early modern times. Analysis of writings from Plato through medieval theorists to those of the Seventeenth Century. 3016: The thought and ethical implications of philosophers from the late Seventeenth Century to the present. Analysis of key concepts in the thought of theorists from the early modern period until the present.
Prerequisite(s): PSCI 2014
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3016, PPE 3016

PSCI 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3034, IS 3034

PSCI 3044 - The Politics of Internet Governance (3 credits)
Introduces students to theoretical, technological, and policy debates in Internet governance. Topics include multistakeholder governance, cybersecurity and cybercrime, network investigative techniques, data protection, vulnerability disclosure, use of anonymity-granting technologies, network neutrality, virtual currencies, big data, algorithmic bias and decision-making, politics of the domain name system, privacy, free expression, cross-border dispute resolution, data ownership, and challenges to state authority.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3044

PSCI 3054 - The Dark Web and Threat Analytics (3 credits)
Introduction to dual-use anonymity-granting technologies such as the Dark Web. Covers open source threat intelligence as a technique to assess trends and trajectories in anonymous online content. Substantive topics include the use of Dark Web technologies for political expression in repressive regimes, anonymity and privacy protection in an age of big data as well as the misuse of these tools for doxing, trolling, and the creation of illegal markets for drugs, guns, malicious software, human trafficking, and child abuse imagery. Junior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3054

PSCI 3064 - Food Politics (3 credits)
Focuses on how scholars, pundits, citizens, and policymakers think about food on local, national, and global scales. Explores various ways of producing, distributing, and consuming food and how they are implicated in specific organizations of power and possibility. Examines how food, and the discourses surrounding food, help structure understandings of a variety of issues, such as identity, property, labor, gender, race, responsibility, and death.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3064

PSCI 3104 - Security Studies: Theories and Concepts (3 credits)
Introduces the various theoretical approaches to security. Examines key concepts in the field of Security Studies, such as uncertainty, polarity, war, coercion, terrorism, intelligence, genocide, crimes against humanity, ethnic conflict, and human security.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3104

PSCI 3114 - Global Security (3 credits)
Explores various theoretical approaches to security and discusses traditional and non-traditional security issues. Focuses on global, international and regional security challenges and examines alternative strategic and tactical solutions for addressing them.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3114

PSCI 3115 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3115

PSCI 3116 - Selected World Problems (3 credits)
Selected world problems and how they affect various countries and regions. Each semester, a topic will be chosen. 3115: World problems in a global or regional context. 3116: World problems in a European context. 3115 and/or 3116 may be repeated for a combined maximum of 9 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3116

PSCI 3125 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3125

PSCI 3126 - Intelligence and National Security (3 credits)
Introduces students to the field of Intelligence Studies. Focuses on the structure, role and capabilities of the U.S. intelligence community and investigates the relationship between intelligence and national security strategy. Addresses topics pertaining to data collection and intelligence analysis, covert operations and counterintelligence. 3125: Intelligence and National Security. 3126: The Intelligence Process.
Prerequisite(s): IS 3125 or PSCI 3125
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3126

PSCI 3134 - Global Conflict and War (3 credits)
Focuses on the causes, legal and moral constraints, impacts, and consequences of conflict and war. Explores historical and contemporary cases of conflict and war and investigates the role of state and non-state actors in these conflicts. Examines the impact of technology, religion, culture and identity on the present and future of war.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3134

PSCI 3135 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3135

PSCI 3136 - Strategies of Modern Warfare (3 credits)
3135: Analyzes the theory and practice of conventional warfare and investigates how strategic thought has influenced and shaped modern warfare. 3136: Examines the theory and practice of irregular warfare and focuses on the theory and practice of counterinsurgency and counterterrorism.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3136

PSCI 3144 - Global Governance and Public Policy (3 credits)
Examines the norms, institutions, practices and processes developed by the international community to address global problems such as poverty, pandemics, global warming, displaced persons and transnational crim. Utilizes theories of decision- and policy-making and investigates the role of states, international governmental and non-governmental organizations, coalitions and corporations in global public policy-making.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3144

PSCI 3154 - Topics in Global Public Policies (3 credits)
Examines in depth selected global public policies pertaining to health, energy, development, education, refugees or labor. May be repeated with different content for a maximum of nine (9) credits.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 3154

PSCI 3164 - Global Trade: Structures and Policies (3 credits)
Focuses on the operations of global trading system and its structure, theories of trade in international political economy, world trading powers and international and regional trade international organizations such as the World Trade Organization (WTO), the European Union (EU), the United States-Mexico-Canada Agreement (USMC), European Union (EU), United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Development Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and their policies.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3164

PSCI 3165 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNCTAD), the United Nations Industrial Organization (UNIDO) and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance- Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3165

PSCI 3166 - Global Economic Governance and Policy (3 credits)
3165: International Trade - Focuses on the operations of global and regional international organizations such as the World Trade Organization (WTO), the European Union (EU), the United Nations Conference on Trade and Development (UNIDO), and the World Intellectual Property Organization (WIPO) and examines their policies and regulations. 3166: International Finance- Focuses on the operations of global and regional international organizations such as the International Monetary Fund (IMF) and World Bank, the European Union (EU), the Organization for Economic Cooperation and Development (OECD) and examines their policies and regulations.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3166

PSCI 3174 - Monetary Foundations of the World Economy (3 credits)
Focuses on the evolution the operations of global and structure of regional international organizations such as the International Monetary Fund (IMF) and World Bank, the global financial and monetary order. Theories of the global and monetary system in international political economy, the structure of world finance, international financial institutions, the rise of new financial powers in the world economy, central banking, monetary and financial regulation and financial crises and policy responses.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3174

PSCI 3175 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3175

PSCI 3176 - Global Development (3 credits)
3175: The Politics of Development - Examines issues and politics of the developing world and investigates the forces that promote or cut off economic development in low-income countries. Discusses development issues in various world regions. 3176: Economic Development - Emphasizes economic development and focuses on domestic and international policies aiming at addressing poverty in the developing world.
Prerequisite(s): (IS 2054 or PSCI 2054 or GEOG 2054) and (IS 2064 or PSCI 2064 or GEOG 2064)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3176

PSCI 3184 - Human Security (3 credits)
Introduces the field of human security and examines the conceptual, theoretical and methodological issues surrounding it. Identifies the relevant human security actors, explores the tools of human security, and discusses the application of human security. Investigates the implications of human security and discusses its future.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3184

PSCI 3194 - Nuclear Strategy & Politics (3 credits)
Examines the fundamentals of nuclear strategy and investigates the politics associated with the acquisition and proliferation of nuclear weapons. Focuses on nuclear doctrines and policies and explores international efforts associated with nuclear arms control and disarmament. Analyzes the nuclear postures of various nuclear states.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3194

PSCI 3214 - Political Participation (3 credits)
Levels and types of political participation; reasons for participation; who participates and why; effects of political activity on political processes.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3224 - Public Opinion (3 credits)
Sources and distribution of public opinion; measurement of public opinion; relationships between public opinion and public policy; institutions linking public opinion to government decisions.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3234 - Voting and Elections (3 credits)
Voting, elections, and support for political parties and party leaders in the United States and other Western democracies; impact of economic conditions on political support and patterns of realignment and dealignment.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3244 - Political Communication (3 credits)
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 3244

PSCI 3254 - Media and Politics (3 credits)
Explore the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JMC 3254

PSCI 3255 - The Politics of Race, Ethnicity and Gender (3 credits)
Studies the status and political behavior of selected political minorities. 3255: compares African-, Mexican- and Native-Americans. 3256: examines diverse political responses to traditional gender roles, current gender issues, and the unique gender problems facing people of color.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3256 - The Politics of Race, Ethnicity and Gender (3 credits)
Studies the status and political behavior of selected political minorities. 3255: compares African-, Mexican- and Native-Americans. 3256: examines diverse political responses to traditional gender roles, current gender issues, and the unique gender problems facing people of color.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3274 - Political Parties (3 credits)
Development, organization, activities, and personnel of political parties; citizens partisan attitudes and behavior; origins, characteristics, stability, and changes of party systems.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3314 - Congress (3 credits)
Congressional structure; organization and procedure; characteristics of members of Congress; Congressional elections; decision-making and external influences; change and reform.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3324 - The Presidency (3 credits)
Election, institutionalization, staffing, relations with Congress, and the bureaucracy; initiation and implementation of public policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3334 - Judicial Process (3 credits)
Structure and functions of American legal institutions; participants in the process, impact of legal institutions on society.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3344, UAP 3344

PSCI 3354 - Constitutional Law: Structures and Relationships (3 credits)
Power and authority of president, Congress, and courts; division of powers between states and federal government.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3364 - Constitutional Law: Civil and Political Rights (3 credits)
Civil rights and liberties; rights of criminal defendants; competing conceptions of constitutional rights.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3374 - The Politics of Energy (3 credits)
Critical and humanistic perspectives of energy and its global problems. Politics and ethics of fuel extraction, distribution, and consumption across cultures and histories. Energy narratives, discourses, and aesthetics in the formation of political identities. Energy and the rise of modern democracy and global capitalism, with an emphasis on the energy dimensions of climate justice. Pre: Junior Standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3374

PSCI 3384 - Politics of Global and Comparative Migration (3 credits)
Theories and politics of international migration. How policies in destination, transit, and origin countries influence migration. Why governments adopt the migration policies they do. Impacts of global, regional, and national politics and policies on migration among countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3384

PSCI 3394 - Comparative Politics of Immigrant Inclusion (3 credits)
Theories of citizenship applied across levels of government. Comparative policies for political, social, and military inclusion. Explanations for variations in policies supporting citizenship and inclusion across countries. Explanations for differences among immigrants' political inclusion across countries.
Prerequisite(s): PSCI 1024 or IS 1024 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3394

PSCI 3414 - Public Administration (3 credits)
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3434

PSCI 3424 - State and Local Government (3 credits)
Institutions, functions, and policies of state, county, and municipal governments in the U.S.; issues confronting these governments in the federal system.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3434 - Urban Politics (3 credits)
Basic concepts of urban politics; governmental structures, policy processes, and political conflicts in U.S. cities, policy options for coping with urban problems.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3444 - Administrative Law and Policy (3 credits)
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3444

PSCI 3514 - Latin American Government and Politics (3 credits)
Introduction to the political systems of Latin American countries, including legislative-executive relations, interest groups, political parties, electoral systems, political violence, and socio-political development.
Prerequisite(s): PSCI 1014H or PSCI 1014 or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3514

PSCI 3515 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3515

PSCI 3516 - European Political Systems (3 credits)
The government and politics of selected European states and of the European Union. 3515: normally includes the United Kingdom. 3516: normally includes Germany and Hungary.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3516

PSCI 3524 - Politics of Post-Communist Systems (3 credits)
Institutions, party structures, political economy, elite politics, ethnic conflicts, leadership dynamics, and mass political behavior in Russia and other post-communist political systems.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3524

PSCI 3534 - African Government and Politics (3 credits)
Survey of major concepts and themes in the study of African politics and development: analyses of the state, political institutions, social forces, democratization, sustainable development, issues of contemporary African politics.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3534

PSCI 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc.
Prerequisite(s): PSCI 1024 or PSCI 1024H or JUD 2134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3544, RLCL 3544

PSCI 3554 - Comparative Political Economy (3 credits)
Economic policies and collective choice processes of pre-industrial, industrializing, and advanced industrial states; problems and crises of industrial development, economic distribution, and technological transfer in the transition from an agrarian to advanced industrial society.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3554

PSCI 3564 - Violent Political Change (3 credits)
Historical origins, political processes, and institutional outcomes of violent political change, rising from mass protest movements, revolutionary organization, military coups, and radical political parties.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3574 - Government and Politics of Japan (3 credits)
Introduction to governmental institutions, patterns of political organization and behavior, and key policies of the Japanese political system.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3574

PSCI 3584 - Governments and Politics of Asia (3 credits)
Introduction to governmental institutions, political behavior, and social and economic policy approaches of China and other selected countries in the Asian region.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3584

PSCI 3594 - Topics in Middle East Politics and International Relations (3 credits)
Government and politics of Middle Eastern states. Religion, culture and society in the Middle East. Nationalism and Middle East politics. Regional conflicts and regional security. International relations of the Middle East. Great powers and Middle East politics. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1024 or PSCI 1024 or IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3594

PSCI 3615 - International Relations (3 credits)
Structure and development of the modern international system; theories of international politics; international law; international organizations.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3615

PSCI 3616 - International Relations (3 credits)
Structure and development of the modern international system; theories of international politics; international law; international organizations.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3616

PSCI 3624 - Foreign Policy and Diplomacy (3 credits)
Focuses on actors, issues, and processes pertaining to foreign policy formulation and implementation. Examines theoretical and historical perspectives on foreign policy analysis. Investigates the national security, foreign policy, and diplomacy nexus. Discusses types of diplomacy and diplomatic methods.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3624

PSCI 3625 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, public, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3625

PSCI 3626 - US-Russia Foreign Policies (3 credits)
3625: Formulation of American foreign policy; roles of the President, Congress, press, public, and bureaucracy; central themes, issues, and problems of American diplomacy; 3626: Development and operational practices of Russian foreign policy decision-making in the international environment; party and state political institutions; Marxist-Leninist ideology.
Prerequisite(s): PSCI 1024 or PSCI 1024H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3626

PSCI 3634 - Human Rights: Global Issues (3 credits)
Identification, articulation and clarification of the relationship between human rights and other contemporary international phenomena, issues, events, and processes that affect human rights. Detailed consideration of the diverse traditions and cultural interpretations of human rights.
Prerequisite(s): PSCI 1024 or PSCI 1024H or IS 1024 or IS 1024H or PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3634

PSCI 3684 - Indigenous Peoples and World Politics (3 credits)
A survey of the historical and contemporary struggles of indigenous peoples throughout the world. Examines the dynamics of colonialism (internal and external), identity construction, gender, cultural integrity, and the ongoing global indigenous rights discourse. In addition to covering broad global processes/theoretical approaches, comparative case studies of particular indigenous groups, such as the Maasai (Kenya, Tanzania) and Mayans (Mexico, Guatemala, Belize), are used to highlight the global, regional and intra-community diversity among contemporary indigenous peoples.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 3684

PSCI 3694 - Far-right Violence in the United States (3 credits)
Assessment of theoretical and conceptual foundations to understand the rise of far-right violence in the United States. Identification of causes of radicalization into the far-right. Comparison of case studies of historical and contemporary far-right violence. Evaluation of differences and similarities in historical and contemporary case studies. Appraisal of successful responses to far-right violence.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3694

PSCI 3704 - National Security Strategy (3 credits)
Focuses on the causes of war and the conditions of peace. Examines the logic, levels, and outcomes of strategy and investigates the impact of international law and politics on the use of force. Explores contemporary strategic theory and discusses current issues in grand strategy.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3704

PSCI 3714 - The U. S. Policy Process (3 credits)
Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3714

PSCI 3724 - Poverty and Welfare Policy (3 credits)
Public policies regarding the poor, impact of current policies; future policy options.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3734 - National Security (3 credits)
Post-1945 strategic problems, policies, and security commitments of major participants in international politics, especially the United States and Russia; effects of security policies on international and domestic political economies.
Prerequisite(s): PSCI 2054 or IS 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3734

PSCI 3744 - Public Policy Analysis (3 credits)
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3744

PSCI 3754 - American Political Theory (3 credits)
American political theory from the pre-Revolutionary era to the present. American contribution to the understanding of freedom, equality, political community, constitutionalism, political dissent, and the welfare state.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3764 - Contemporary Democratic Theory (3 credits)
History and critiques of classical theories of democracy; contradictions within and contemporary problems facing democracy; future of democracy according to conservative, liberal, and radical theoretical perspectives.
Prerequisite(s): PSCI 2014 and (PSCI 3015 or PHIL 3015 or PSCI 3016 or PHIL 3016)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3774 - Marxian Political Analysis (3 credits)
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 3774

PSCI 3784 - Origins of the State (3 credits)
Theories of the origins of politics and government; evidence of state formation in prehistoric societies; political behavior in contemporary pre-literate societies as precursor to state formation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064 or PSCI 2084 or IS 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 3795 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3795

PSCI 3796 - Global Terrorism and Counterterrorism (3 credits)
Evaluation of theories and concepts used to analyze terrorism and counterterrorism. Identification and analysis of origins, causes, and consequences of terrorism globally. Comparison of historical and contemporary terrorism and counterterrorism. Appraisal of how histories of colonialism and the growth of new media affect terrorism and responses to terrorism. Identification of successful counterterrorism methods, strategies and practices. Evaluation of ethics and human rights in global counterterrorism. 3795: histories, origins, and spread of terrorism; 3796: strategies and practices of counterterrorism.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3796

PSCI 3804 - European Integration (3 credits)
Analysis of the process of industrial, political, legal, economic, social and cultural integration of states in Europe as a whole or within a European sub-region. History and theories of European integration. Examination of various European organizations whose actions reflect different approaches to and different degrees of integration in Europe.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3804

PSCI 3814 - The European Union: Institutions and Policies (3 credits)
Evolution, organizational structure, political dynamics, and decision-making mechanisms of the European Union. Major internal and external EU policies such as foreign, security and defense policy, economics, Single Market, and monetary union.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3814

PSCI 3824 - European Union's Foreign and Security Policy (3 credits)
The European Union (EU) as an actor in the foreign, security and defense policy fields. The external relations of the EU and its role in world affairs. The institutional arrangements of EU external relations and EU activity in policy areas including human rights, peacekeeping, environmental governance, trade, and economic development.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3824

PSCI 3825 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3825

PSCI 3826 - European Union's Foreign Relations (3 credits)
The global strategy and foreign policy objectives of the European Union and the evolving relations between the EU and the rest of the world. EU's role in world affairs. 3825: EU's global strategy and its relations with major world powers, such as the United States, Russia, and China. 3826: EU's global strategy and its relations with countries in various world regions as well as global multilateral organizations, such as the United Nations (UN) and the World Trade Organization (WTO).
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3826

PSCI 3834 - European Security Governance (3 credits)
Structure and function of major European security organizations, such as the North Atlantic Treaty Organization (NATO), the European Union (EU), the Organization for Security and Cooperation in Europe (OSCE), and the Collective Security Treaty Organization (CSTO). In-depth analysis of those organizations' role in the European security architecture. Examination of inter-organizational cooperation in addressing European security issues and conflicts.
Prerequisite(s): IS 3804 or PSCI 3804
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3834

PSCI 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 3844, IS 3844

PSCI 3854 - European Political Economy (3 credits)
The European Union's major institutions and policies relating to economic and monetary union and trade. Monetary integration, fiscal and economic policy cooperation, financial integration (including the banking union), the single market and the common commercial policy, the common agricultural policy and the EU's regional policy. The internal structure and organization of the European political economy and the external dimension of Europe and its impact on global economics, ranging from the World Trade Organization to EU enlargement and the Developing World.
Prerequisite(s): IS 3814 or PSCI 3814
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3854

PSCI 3874 - The European Business Environment (3 credits)
Political, legal, economic, socio-cultural, technological and environmental issues and policies affecting the operation and strategies of foreign companies in Europe. Business operations inside and outside the European Union. Impact of EU policies and the EU legal framework on business strategies and policies of non-EU companies. Business strategy for the European market, marketing and human resources management in Europe, and corporate governance and control in Europe. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3874, MGT 3874

PSCI 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ECON 3884, PHIL 3884, PPE 3884

PSCI 3894 - Transatlantic Relations Since 1945 (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3894

PSCI 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 3914, IS 3914

PSCI 3924 - Theories of Transatlantic Relations (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3924

PSCI 3934 - NATO & European Security (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3934

PSCI 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4024 - Seminar in Diplomacy and Security (3 credits)
In-depth analysis of selected topics in diplomacy, strategy, and national security including issues pertaining to international conflict and cooperation; dimensions of national power; objectives of national policy and implementation of national strategy; diplomatic negotiations; and conflict resolution. Senior Standing.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4024

PSCI 4034 - Topics in Diplomacy Lab (3 credits)
Examines the fundamentals of policy analysis and formulation and emphasizes research and writing on topics pertaining to diplomacy, security, and foreign policy. Focuses on policy analysis and evaluation and concentrates on policy design. Emphasizes preparation and presentation of policy reports. May be taken three times for credit with different policy topics. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4034

PSCI 4054 - Seminar in Global Political Economy (3 credits)
Examines theoretical and historical approaches to global political economy and assesses their practical implications. Focuses on issue areas such as production, trade, money, finance and investment and analyzes their implications for the global economic and political order. Investigates issues pertaining to economies of development and in transition. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4054

PSCI 4064 - Seminar in Global Development (3 credits)
Examines how economic and political forces interact in the developing world, discusses the history of these interactions from the pre-colonial period to the present and explores how colonialism shaped the developing worlds economic and political trajectories. Utilizes case studies, historical analysis and development economies to better understand the economic and political condition of countries in the developing world. Senior Standing.
Prerequisite(s): IS 2064 or PSCI 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4064

PSCI 4074 - The Politics of Cybersecurity (3 credits)
Analyses the politics of cybercrime, cyberwar, and the challenges of producing effective cybersecurity. Topics include the economics of cybersecurity, the cross-border nature of global cybercrime, encryption and anonymity-granting technologies, targeting critical national infrastructure, network investigative techniques, cybersecurity measurement, politics of zero-day vulnerabilities, and the process of providing effective cybersecurity at the individual, organizational, subnational, and national levels.
Prerequisite(s): PSCI 3044 or IS 3044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4074

PSCI 4104 - Topics in European Studies (3 credits)
Selected issues pertaining to European Studies, such as racism in Europe, European art and society, religion and society in Europe, gender politics, and demographic trends in Europe. May be repeated twice with different content for a maximum of nine (9) credits. Pre: Senior Standing.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4104

PSCI 4144 - Topics in Transatlantic Relations (3 credits)
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4144

PSCI 4154 - Topics in Transatlantic Studies (3 credits)
Research and analysis of selected issues pertaining to transatlantic studies. Topics under examination include: religion and the transatlantic world; the political economy of the transatlantic slave trade; and the role of culture, language, and literature in cementing transatlantic ties. May be repeated twice with different content for a maximum of nine (9) credits.
Prerequisite(s): IS 1114 or PSCI 1114
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: IS 4154

PSCI 4164 - Future of Security: Integrative Solutions for Complex Security Systems (3 credits)
Identification and analysis of complex, real-world security problems and threats to people, organizations, and nations across multiple domains, roles and future scenarios. Crisis communication, decision making tools, ethical principles and problem-solving methods to respond, assess options, plan, scope, and communicate before, during and after conflicts, disasters and attacks. Use of an experiential learning facility, and participation in a reality-based team simulation of cascading security and disaster events.
Prerequisite(s): PSCI 2164 or BIT 2164 or CS 2164
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BIT 4164, CS 4164

PSCI 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4174, IS 4174

PSCI 4184 - Capstone Project Transatlantic Studies (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4184

PSCI 4214 - Senior Seminar in Political Behavior (3 credits)
Political behavior: socialization, voting, opinion formation and expression, decision-making in government, as explained by personality, rationality, culture, class, and institutional roles. Topics vary from semester to semester as announced. Senior standing.
Prerequisite(s): PSCI 3214 or PSCI 3224 or PSCI 3234 or PSCI 3244 or PSCI 3264 or PSCI 3274
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4314 - Senior Seminar in Political Institutions (3 credits)
Selected topics in political institutions, including decision-making, types and structures of political institutions, internal and external influences on institutional behavior. Topics vary from semester to semester. Senior standing.
Prerequisite(s): PSCI 3314 or PSCI 3324 or PSCI 3334 or PSCI 3515 or PSCI 3516 or PSCI 3524
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4324 - Senior Seminar in Constitutional Law (3 credits)
Cases, law review articles, and related materials containing describing, or commenting on major decisions of the U.S. Supreme Court. Topics vary from semester to semester as announced. Senior standing.
Prerequisite(s): PSCI 3354 or PSCI 3364
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4414 - Senior Seminar in Public Administration (3 credits)
Selected topics in public administration, including norms of practice, government personnel, administrative process, administrative law, privatizing, and contracting. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3414 or PSCI 3424 or PSCI 3444
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4514 - Senior Seminar in Comparative Politics (3 credits)
Selected topics in the comparative analysis of political behavior, processes, and institutions; cross-national institutional and aggregate data analysis. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3515 or PSCI 3516 or PSCI 3524 or PSCI 3554 or PSCI 3564 or PSCI 3514 or PSCI 3534 or PSCI 3544 or PSCI 3574 or PSCI 3584
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4614 - Senior Seminar in International Relations (3 credits)
Selected topics in international relations, including objectives of national policy, dimensions and components of national power, comparative diplomacy, international conflict and cooperation, instruments for conflict resolution. Topics vary from semester to semester as announced. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3615 or PSCI 3616 or IS 3615 or IS 3616 or PSCI 3625 or PSCI 3626 or PSCI 3734 or IS 3626 or IS 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4614

PSCI 4624 - The Washington Semester: Seminar in American Politics and Public Policy (3 credits)
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4624

PSCI 4644 - Washington Semester: Politics, Policy and Administration in A Democracy (3 credits)
This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4644

PSCI 4714 - Senior Seminar in Policy Analysis (3 credits)
Theoretical, analytical, and methodological approaches used to assess government activities and public policy. Topics vary from semester to semester as announced. Must have senior standing.
Prerequisite(s): PSCI 3724 and PSCI 3734
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4714

PSCI 4724 - Senior Seminar in Political Theory (3 credits)
Selected topics in analytic political philosophy, contemporary ideologies, and democratic theory. Topics vary from semester to semester as announced. Senior standing required. Must have senior standing and any two of the prerequisites.
Prerequisite(s): PSCI 3015 or PHIL 3015 or PSCI 3016 or PHIL 3016 or PSCI 3754 or PSCI 3764 or PSCI 3774 or UAP 3774
Instructional Contact Hours: (3 Lec, 3 Crd)

PSCI 4734 - Theories and Practices of International Conflict Management (3 credits)
Examines alternative perspectives on peace, security, and international intervention and their implications for policy. Focuses on the role international organizations and other actors in conflict resolution and peace-building and explores issues pertaining to humanitarian intervention, human security, and state-building. Utilizes case studies in peacekeeping and peace building to highlight the link between theory and practice.
Prerequisite(s): PSCI 3616 or IS 3616
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4734

PSCI 4735 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: IS 4735

PSCI 4736 - Topics in Multilateral Diplomacy Workshop (3 credits)
Simulation of diplomatic practice in major global and regional international organizations. Diplomatic strategies and tactics. Effects of decision-making and policy-making structures and processes on diplomatic outcomes. Crisis management and conflict resolutions mechanisms. Diplomatic negotiations and diplomatic resolutions. Extensive use of simulations. 4735: Multilateral diplomacy in global organizations: United Nations (UN) and World Trade Organization (WTO). May be repeated once with different content for a maximum of six (6) credits. 4736: Multilateral diplomacy in sub-global/regional organizations: European Union (EU), North Atlantic Treaty Organization (NATO), and Organization for Security & Cooperation in Europe (OSCE). May be repeated once with different content for a maximum of six (6) credits. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: IS 4736

PSCI 4744 - Intelligence Analysis Workshop (3 credits)
Examines the impact of historical experience and bureaucratic structures on intelligence analysis. Discusses the contents of the intelligence agenda and explores issues pertaining to intelligence analysis. Focuses on the intelligence process and offers a target-centric approach to intelligence analysis. Emphasizes and evaluates the use of structured analytic techniques in intelligence analysis.
Prerequisite(s): IS 2054 or PSCI 2054 or GEOG 2054
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4744

PSCI 4754 - Internship Program (1-19 credits)
Qualified students are placed in an administrative or legislative staff position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Detailed reports on the internship experience and a specific project will be required of each intern. (Variable credit to maximum of 6 credits for a full-time position over an entire semester). Three hours of appropriate advanced American government courses, Junior standing, a screening interview, GPA of 3.00 or better and consent required.
Instructional Contact Hours: Variable credit course

PSCI 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSCI 29843 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Political Science Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required Political Science Courses		
PSCI 1034	Introduction to International Studies and Political Science	3
PSCI 2014	Introduction to Political Theory	3
PSCI 2024	Research Methods in Political Science	3
Select one of the following:		3
PSCI 2054	Introduction to World Politics	
PSCI 2064	The Global Economy and World Politics	
Required Political Science Core Elective Courses		
Select nine hours of courses in Political Science, six of which must be at the 3000 or 4000 level		9
Subtotal		21
Major Requirements		
Political Science Major Courses		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Advanced Theory and Practice in Political Science		
Select one of the following:		3
PSCI 3015	Political Theory	
PSCI 3016	Political Theory	
PSCI 4024	Seminar in Diplomacy and Security	
PSCI 4054	Seminar in Global Political Economy	
PSCI 4064	Seminar in Global Development	
PSCI 4074	The Politics of Cybersecurity	
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	
PSCI 4174	Climate Change and the International Policy Framework	
PSCI 4214	Senior Seminar in Political Behavior	
PSCI 4314	Senior Seminar in Political Institutions	
PSCI 4324	Senior Seminar in Constitutional Law	
PSCI 4414	Senior Seminar in Public Administration	
PSCI 4514	Senior Seminar in Comparative Politics	
PSCI 4614	Senior Seminar in International Relations	
PSCI 4714	Senior Seminar in Policy Analysis	
PSCI 4724	Senior Seminar in Political Theory	

PSCI 4754	Internship Program	
PSCI 4974	Independent Study	
PSCI 4994	Undergraduate Research	
Subtotal		9
Requirements for the Political Science Major (No Option)		
Major Electives		
Minimum of 12 additional hours of courses in Political Science, nine of which must be at the 3000 or 4000 level [1]		12
Required Hours in a Related Field		
12 hours at the 3000 or 4000 level [2]		12
Subtotal		24
Free Electives		
Select 30 credits of free electives		30
Subtotal		30
Pathways to General Education		
Pathways Concept 1 - Discourse [3]		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSCI 1014	Introduction to United States Government and Politics (met by major)	3
PSCI 1024	Comp Gov & Politics (met by major)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
6 credits: 3 design + 3 arts, or 6 integrated design & arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
PSCI 1014	Introduction to United States Government and Politics (met by major)	3
Subtotal		36
Total Credits		**120**

1 Limit on Repeatable Courses: No more than six credit hours in any one of the following courses may contribute toward the 54 hours required by the major: internship (PSCI 4754 (https://catalog.vt.edu/search/?P=PSCI%204754) Internship Program), undergraduate research (PSCI 4994 (https://catalog.vt.edu/search/?P=PSCI%204994) Undergraduate Research), independent study (PSCI 4974 (https://catalog.vt.edu/search/?P=PSCI%204974) Independent Study).

2 12 hours at the 3000 or 4000 level in one of the following departments: Agriculture & Applied Economics, Communication, Economics, Education, English, Geography, History, Philosophy, Psychology, Religion and Culture, Science and Technology Studies, Sociology, Urban Affairs & Planning, or a single Foreign Language.

3 PSCI majors (all options) must complete the requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu.

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete PSCI 1014 Introduction to United States Government and Politics, PSCI 1024 Comp Gov & Politics, and PSCI 2024 Research Methods in Political Science by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with a Political Science degree.

In Major GPA

All of the courses in the Degree Core Requirements, Major Requirements, And Option Requirements are included in the in-major GPA. The overall and in-major GPAs required for graduation are 2.0.

Free Electives

Hours not required by the Curriculum for Liberal Education or the major are “free electives” and may be taken anywhere in the university.

Prerequisites

Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements. These courses are noted with Footnote 1.

Regarding Double Majors and Minors

The Department of Political Science offers majors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy as well as minors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy. Courses for the majors and minors overlap significantly. Therefore, Political Science majors may not pursue multiple majors and/or minors within the department.

Acceptable Substitutions

SOC 3204 for PSCI 2024

Foreign Language Requirements

Foreign Language

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete 3 years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete 2 years of a single foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or

the equivalent in college (these 3 hours do count toward the 120 required for graduation and calculate into the GPA) **or**

- Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these 6 hours do **not** count toward the 120 required for graduation)

Political Science Major with Legal Studies Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required Political Science Courses		
PSCI 1034	Introduction to International Studies and Political Science	3
PSCI 2014	Introduction to Political Theory	3
PSCI 2024	Research Methods in Political Science	3
PSCI 2054	Introduction to World Politics	3
or PSCI 2064	The Global Economy and World Politics	
Required Political Science Core Elective Courses		
Select nine hours of courses in Political Science, six of which must be at the 3000 or 4000 level		9
Subtotal		21
Major Requirements		
Political Science Major Courses		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Advanced Theory and Practice in Political Science		
Select one of the following:		3
PSCI 3015	Political Theory	
PSCI 3016	Political Theory	
PSCI 4024	Seminar in Diplomacy and Security	
PSCI 4054	Seminar in Global Political Economy	
PSCI 4064	Seminar in Global Development	
PSCI 4074	The Politics of Cybersecurity	
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	
PSCI 4174	Climate Change and the International Policy Framework	
PSCI 4214	Senior Seminar in Political Behavior	
PSCI 4314	Senior Seminar in Political Institutions	
PSCI 4324	Senior Seminar in Constitutional Law	
PSCI 4414	Senior Seminar in Public Administration	
PSCI 4514	Senior Seminar in Comparative Politics	
PSCI 4614	Senior Seminar in International Relations	
PSCI 4714	Senior Seminar in Policy Analysis	
PSCI 4724	Senior Seminar in Political Theory	
PSCI 4754	Internship Program	
PSCI 4974	Independent Study	
PSCI 4994	Undergraduate Research	
Subtotal		9
Requirements for the Political Science Major (Legal Studies Option)		
Legal Studies Philosophy Courses		
PHIL 1204	Knowledge and Reality	3
PHIL 1304	Morality and Justice	3
Legal Studies Political Science Courses		
Select two of the following:		6
PSCI 3334	Judicial Process	
PSCI 3354	Constitutional Law: Structures and Relationships	
PSCI 3364	Constitutional Law: Civil and Political Rights	
PSCI 3444	Administrative Law and Policy	
PSCI 4324	Senior Seminar in Constitutional Law	
Political Science Electives		
Select a minimum of six additional hours of courses in Political Science, 3 of which must be at the 3000 or 4000 level. [1]		6
Required Hours in Legal Studies Related Courses		
Select four of the following:		12
AAEC 3314	Environmental Law	
AAEC 3604	Agricultural Law	
COMM 4024	Communication Law	
CRIM 3414	Criminology	
CRIM 3434	Systems of Justice	
CRIM 3474	Women and Crime	
CRIM 4424	Juvenile Delinquency	
CRIM 4454	Topics in Criminology	
CRIM 4474	Cyber Criminology	
ECON 4894	Law and Economics	
ENGL 3684	Literature and the Law	
FIN 3054	Legal and Ethical Environment of Business	
FIN 4004	Wills, Trusts, and Estates	
FIN 4014	Cyberlaw and Policy	
HD 4354	Family, Law, and Public Policy	
JMC 4344	Free Speech in Cyberspace	
PHIL 4334	Jurisprudence	
REAL 4754	Real Estate Law	
SOC 4404	Sociology of Law	
STL 4304	Intellectual Property Law	
STL 4314	Current Topics in Science, Technology and Law	
STL 4324	Global Aspects of Intellectual Property Law	
STL 4334	Patent Preparation and Prosecution	
UAP 4344	Law of Critical Environmental Areas	
UAP 4754	Legal Foundations of Planning	
Subtotal		30
Free Electives		
Select remaining courses to complete 120 credit hour graduation requirement		15
Subtotal		15
Pathways to General Education [2]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3

Pathways Concept 2 - Critical Thinking in the Humanities		
PHIL 1204	Knowledge and Reality	3
PHIL 1304	Morality and Justice	3
Pathways Concept 3 - Reasoning in the Social Sciences (Met by Major Requirements)		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits: 3 design + 3 arts, or 6 integrated design & arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (Met by Major Requirements)		
PSCI 1014	Introduction to United States Government and Politics	3
Subtotal		45
Total Credits		**120**

[1] Limit on Repeatable Courses: No more than six credit hours in any one of the following courses may contribute toward the 54 hours required by the major: internship (PSCI 4754 (https://catalog.vt.edu/search/?P=PSCI%204754) Internship Program), undergraduate research (PSCI 4994 (https://catalog.vt.edu/search/?P=PSCI%204994) Undergraduate Research), independent study (PSCI 4974 (https://catalog.vt.edu/search/?P=PSCI%204974) Independent Study).

[2] PSCI majors (all options) must complete the requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu.

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete PSCI 1014 Introduction to United States Government and Politics , PSCI 1024 Comp Gov & Politics , and PSCI 2024 Research Methods in Political Science by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with a Political Science degree.

In Major GPA

All of the courses used in the degree core, major, and option requirements are included in the in-major GPA. The overall and in-major GPAs required for graduation are 2.0.

Free Electives

Hours not required by Pathways General Education or the major are “free electives” and may be taken anywhere in the university.

Prerequisites

Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements.

Regarding Double Majors and Minors

The Department of Political Science offers majors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy as well as minors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy. Courses for the majors and minors overlap significantly. Therefore, Political Science majors may not pursue multiple majors and/or minors within the department.

Acceptable Substitutions

SOC 3204 for PSCI 2024

Foreign Language Requirement

Foreign Language

- Students who completed three years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete three years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete two years of a single foreign, classical, or sign language in high school plus an 1106 foreign language or the equivalent in college (these three hours do count toward the 120 required for graduation and calculate into the GPA) **or**
  - Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these six hours do **not** count toward the 120 required for graduation)

Political Science Major with National Security Studies Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required Political Science Courses		
PSCI 1034	Introduction to International Studies and Political Science	3
PSCI 2014	Introduction to Political Theory	3
PSCI 2024	Research Methods in Political Science	3
PSCI 2054	Introduction to World Politics	3
or PSCI/GEOG/IS 2064	The Global Economy and World Politics	
Required Political Science Core Elective Courses		
Select 9 hours of courses in Political Science, 6 of which must be at the 3000 or 4000 level		9
Subtotal		21

Major Requirements		
Political Science Major Courses		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Advanced Theory and Practice in Political Science		
Select one of the following:		3
PSCI 3015	Political Theory	
PSCI 3016	Political Theory	
PSCI 4024	Seminar in Diplomacy and Security	
PSCI 4054	Seminar in Global Political Economy	
PSCI 4064	Seminar in Global Development	
PSCI 4074	The Politics of Cybersecurity	
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	
PSCI 4174	Climate Change and the International Policy Framework	
PSCI 4214	Senior Seminar in Political Behavior	
PSCI 4314	Senior Seminar in Political Institutions	
PSCI 4324	Senior Seminar in Constitutional Law	
PSCI 4414	Senior Seminar in Public Administration	
PSCI 4514	Senior Seminar in Comparative Politics	
PSCI 4614	Senior Seminar in International Relations	
PSCI 4714	Senior Seminar in Policy Analysis	
PSCI 4724	Senior Seminar in Political Theory	
PSCI 4754	Internship Program	
PSCI 4974	Independent Study	
PSCI 4994	Undergraduate Research	
Subtotal		9
Requirements for the Political Science Major (National Security Studies Option)		
National Security Studies Political Science Courses		
Select three of the following:		9
PSCI 3104	Security Studies: Theories and Concepts	
PSCI 3114	Global Security	
PSCI 3125	Intelligence and National Security	
PSCI 3126	Intelligence and National Security	
PSCI 3134	Global Conflict and War	
PSCI 3135	Strategies of Modern Warfare	
PSCI 3136	Strategies of Modern Warfare	
PSCI 3194	Nuclear Strategy & Politics	
PSCI 3314	Congress	
PSCI 3324	The Presidency	
PSCI 3564	Violent Political Change	
PSCI 3624	Foreign Policy and Diplomacy	
PSCI 3625	US-Russia Foreign Policies	
PSCI 3626	US-Russia Foreign Policies	
PSCI 3694	Far-right Violence in the United States	
PSCI 3704	National Security Strategy	
PSCI 3734	National Security	
PSCI 3735		
PSCI 3736		
IS/PSCI 3795	Global Terrorism and Counterterrorism	
IS/PSCI 3796	Global Terrorism and Counterterrorism	
PSCI 3824	European Union's Foreign and Security Policy	
PSCI 3825	European Union's Foreign Relations	
PSCI 3826	European Union's Foreign Relations	
PSCI 3834	European Security Governance	
PSCI 3844	European Geopolitics	
PSCI 3934	NATO & European Security	
PSCI 4034	Topics in Diplomacy Lab	
PSCI 4074	The Politics of Cybersecurity	
PSCI 4734	Theories and Practices of International Conflict Management	
PSCI 4735	Topics in Multilateral Diplomacy Workshop	
PSCI 4736	Topics in Multilateral Diplomacy Workshop	
PSCI 4744	Intelligence Analysis Workshop	
Political Science Electives		
Select a minimum of 3 additional hours of courses in Political Science [1]		3
Required Hours in National Security Related Courses		
Select four of the following: [2]		12
ARBC 3274	War and Arab Culture	
AS 4215	National Security Forces in Contemporary American Society	
AS 4216	National Security Forces in Contemporary American Society	
GEOG 3034	The CIA: Its Capabilities in Todays Geo-Political World	
GEOG 4084	Modeling with Geographic Information Systems	
GEOG 4314	Spatial Analysis in Geographic Information Systems	
GEOG 4354	Introduction to Remote Sensing	
HIST 3254	The Vietnam War	
HIST 3394		
HIST 3374	French Empire	
HIST 3484	Nazi Germany: History and Memory	
HIST 3524		
HIST 3534	Modern Military History	
HIST 3544	World War II	
HIST 3554	Age of Globalization	
HIST 3564	The Cold War	
HIST 3594	The Rise of Modern Latin America	
HIST 3644	Twentieth-Century Russia	
HIST 3654	Arab-Israeli Conflict	
HIST 3664	Revolutionary China	
HIST 3684		
HUM 3204	Multicultural Communication	
JMC 4044	International Communication	
MGT 3804	Topics for Cadet Global Leadership Studies	
MN 3005	Navigation and Naval Operations	
MN 3006	Navigation and Naval Operations	
MN 3204	Evolution of Warfare	
MN 4204	Amphibious Warfare	
MS 3005	Military Science III, Army Reserve Officer Training Corps	

MS 3006	Military Science III, Army Reserve Officer Training Corps	
RLCL 3494	The Holocaust	
SOC 3504	Population Trends and Issues	
Subtotal		24
Free Electives		
Select remaining courses to complete 120 credit hour graduation requirement		21
Subtotal		21
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select 3 hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences (Met by Major Requirements)		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select 6 hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select 3 hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits: 3 design + 3 arts, or 6 integrated design & arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States (Met by Major Requirements)		
PSCI 1014	Introduction to United States Government and Politics	3
Subtotal		45
Total Credits		**120**

1 Limit on Repeatable Courses: No more than six credit hours in any one of the following courses may contribute toward the 54 hours required by the major: internship (PSCI 4754 Internship Program), undergraduate research (PSCI 4994 Undergraduate Research), independent study (PSCI 4974 Independent Study).

2 Limit on Related Courses: No more than six (6) credit hours in any of the following courses may count toward the 12 Required Hours in National Security Related Courses: AS 4215 National Security Forces in Contemporary American Society, AS 4216 National Security Forces in Contemporary American Society, MGT 3804 Topics for Cadet Global Leadership Studies MS 3005 Military Science III, Army Reserve Officer Training Corps, MS 3006 Military Science III, Army Reserve Officer Training Corps, MN 3005 Navigation and Naval Operations, MN 3006 Navigation and Naval Operations, MN 3204 Evolution of Warfare, MN 4204 Amphibious Warfare.

3 PSCI majors (all options) must complete the requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu (https://www.pathways.prov.vt.edu/).

Satisfactory Progress: To proceed satisfactorily toward a degree, a student must complete PSCI 1014 Introduction to United States Government and Politics, PSCI 1024 Comp Gov & Politics, and PSCI 2024 Research Methods in Political Science by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0.

Graduation Requirements

Hours Requirement: A total of 120 hours is required to graduate with a Political Science degree.

In major GPA: All of the courses in the Degree Core Requirements, Major Requirements, And Option Requirements are included in the in-major GPA.

Regarding Double Majors and Minors: The Department of Political Science offers majors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy as well as minors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy. Courses for the majors and minors overlap significantly. Therefore, Political Science majors may not pursue multiple majors and/or minors within the department.

Free Electives: Hours not required by the Curriculum for Liberal Education or the major are “free electives” and may be taken anywhere in the university.

Foreign Language Requirements

Foreign Language:

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete 3 years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete 2 years of a single foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college (these 3 hours do count toward the 120 required for graduation and calculate into the GPA) **or**
  - Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these 6 hours do **not** count toward the 120 required for graduation)

Political Science Major with Social and Political Justice Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required Political Science Courses		

PSCI 1034	Introduction to International Studies and Political Science	3
PSCI 2014	Introduction to Political Theory	3
PSCI 2024	Research Methods in Political Science	3
PSCI 2054	Introduction to World Politics	3
or PSCI 2064	The Global Economy and World Politics	
Required Political Science Core Elective Courses		
Select nine hours of courses in Political Science, six of which must be at the 3000 or 4000 level		9
Subtotal		21
Political Science Major Requirements		
PSCI 1014	Introduction to United States Government and Politics	3
PSCI 1024	Comp Gov & Politics	3
Advanced Theory and Practice in Political Science		
Select one of the following:		3
PSCI 3015	Political Theory	
PSCI 3016	Political Theory	
PSCI 4024	Seminar in Diplomacy and Security	
PSCI 4054	Seminar in Global Political Economy	
PSCI 4064	Seminar in Global Development	
PSCI 4074	The Politics of Cybersecurity	
PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems	
PSCI 4174	Climate Change and the International Policy Framework	
PSCI 4214	Senior Seminar in Political Behavior	
PSCI 4314	Senior Seminar in Political Institutions	
PSCI 4324	Senior Seminar in Constitutional Law	
PSCI 4414	Senior Seminar in Public Administration	
PSCI 4514	Senior Seminar in Comparative Politics	
PSCI 4614	Senior Seminar in International Relations	
PSCI 4714	Senior Seminar in Policy Analysis	
PSCI 4724	Senior Seminar in Political Theory	
PSCI 4754	Internship Program	
PSCI 4974	Independent Study	
PSCI 4994	Undergraduate Research	
Subtotal		9
Requirements for the Political Science Major (Social and Political Justice Option)		
Select three of the following:		9
PSCI 3064	Food Politics	
PSCI 3154	Topics in Global Public Policies	
PSCI 3175	Global Development	
PSCI 3176	Global Development	
PSCI 3255	The Politics of Race, Ethnicity and Gender	
PSCI 3256	The Politics of Race, Ethnicity and Gender	
PSCI 3264		
PSCI 3334	Judicial Process	
PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
PSCI 3364	Constitutional Law: Civil and Political Rights	
PSCI 3384	Politics of Global and Comparative Migration	
PSCI 3394	Comparative Politics of Immigrant Inclusion	
PSCI 3424	State and Local Government	
PSCI 3434	Urban Politics	
PSCI 3444	Administrative Law and Policy	
PSCI 3634	Human Rights: Global Issues	
PSCI 3684	Indigenous Peoples and World Politics	
PSCI 3714	The U. S. Policy Process	
PSCI 3724	Poverty and Welfare Policy	
PSCI 3744	Public Policy Analysis	
PSCI 3754	American Political Theory	
PSCI 3764	Contemporary Democratic Theory	
PSCI 3774	Marxian Political Analysis	
PSCI 3784	Origins of the State	
PSCI 4054	Seminar in Global Political Economy	
PSCI 4064	Seminar in Global Development	
PSCI 4324	Senior Seminar in Constitutional Law	
PSCI 4414	Senior Seminar in Public Administration	
Select a minimum of 3 additional hours of courses in Political Science [1]		3
Select four of the following:		12
AFST 3444	African American Images in Film	
AFST 3454	African American Leadership for Social Change	
AFST 3864		
ALCE 4304	Community Education and Development	
CRIM 3434	Systems of Justice	
ECON 3024	Economic Justice	
ECON 3034	Economics of Poverty and Discrimination	
ECON 4014	Environmental Economics	
ECON 4044	Public Economics	
ECON 4214	Economics of Health Care	
ENGL 3134	Gender and Linguistics	
ENGL 3624	Appalachian Literature	
ENGL 3644	The Postcolonial Novel	
ENGL 3654	Ethnic American Literature	
ENGL 3684	Literature and the Law	
ENGL 3694	Topics in World Novels	
ENGL 3734	Community Writing	
ENGL 3834	Intercultural Issues in Professional Writing	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 3244	The U.S. City	
HD 3024	Community Analytics	
HD 3114	Issues in Aging	
HD 4324	Advanced Family Relationships	
HD 4364	Gender And Family Diversity	
HIST 3105	Women in U S History	
HIST 3106	Women in U S History	
HIST 3114		
HIST 3144	American Environmental History	
HIST 3174	Native American History	
HIST 3494	The Holocaust	
HIST 3554	Age of Globalization	

JMC 4044	International Communication	
JMC 4064	Social Media Analytics	
JMC 4264	Social Media Theory and Practice	
JMC 4334	Communication Ethics	
JMC 4344	Free Speech in Cyberspace	
PHIL 3314	Ethical Theory	
PHIL 3324	Biomedical Ethics	
PHIL 3334	Ethical Perspectives on Artificial Intelligence	
PHS 4044	Public Health Policy and Administration	
PSVP 4104	Global Society, Violence and the Prospects for Peace	
PSVP 4444	Schools, Violence, and Justice	
SOC 3004	Social Inequality	
SOC 3014	Gender Relations	
SOC 3314	Social Movements	
SOC 3404	Environmental Justice	
SOC 3464	Appalachian Communities	
SOC 3614	Gender and Work in the U.S.	
SOC 4094	Appalachian Community Research	
SOC 4404	Sociology of Law	
SOC 4704	Medical Sociology	
SOC 4714	Sociology of Mental Illness	
SPIA 4454	Future of Cities	
SPIA 4464	Data and the Art of Policy-Making and Planning	
STS 3104	Science and Technology in Modern Society	
STS 3284	Technology and Disability	
STS 3314	Medical Dilemmas and Human Experience	
STS 3334	Energy and Society	
STS 4304	Contemporary Issues in Science, Technology, and Society	
STS 4314	Narrative Medicine	
STS 4704	Gender and Science	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4214	Gender, Environment, and International Development	
UAP 4344	Law of Critical Environmental Areas	
UAP 4374	Land Use and Environment: Planning and Policy	
UAP 4754	Legal Foundations of Planning	
WGS 3214	Global Feminisms	
Subtotal		24
Free Electives		
Select remaining courses to complete 120 credit hour graduation requirement		30
Subtotal		
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select one of the following:		6
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing	
COMM 1015 & COMM 1016	Communication Skills and Communication Skills	
Select 3 credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSCI 1014	Introduction to United States Government and Politics (Met by Major Requirements)	
PSCI 1024	Comp Gov & Politics (Met by Major Requirements)	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select six credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) and Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
PSCI 1014	Introduction to United States Government and Politics (Met by Major Requirements)	
Subtotal		66
Total Credits		**120**

[1] Limit on Repeatable Courses: No more than six credit hours in any one of the following courses may contribute toward the 54 hours required by the major: internship (PSCI 4754 Internship Program), undergraduate research (PSCI 4994 Undergraduate Research), independent study (PSCI 4974 Independent Study).

[2] PSCI majors (all options) must complete the requirements for the Pathways to General Education. More details and course listings can be found at the following link: https://www.pathways.prov.vt.edu.

Satisfactory Progress

To proceed satisfactorily toward a degree, a student must complete PSCI 1014 Introduction to United States Government and Politics, PSCI 1024 Comp Gov & Politics, and PSCI 2024 Research Methods in Political Science by the end of the semester in which 60 hours have been attempted; must maintain an overall GPA of at least 2.0 and must maintain an in major GPA of 2.0

Graduation Requirements

Hours Requirement

A total of 120 hours is required to graduate with a Political Science degree.

In Major GPA

All of the courses in the Degree Core Requirements, Major Requirements, and Option Requirements are included in the in-major GPA. The overall and in-major GPAs required for graduation are 2.0.

Free Electives

Hours not required by the Curriculum for Liberal Education or the major are “free electives” and may be taken anywhere in the university.

Prerequisites

Some courses required for this major have pre-/co-requisite and/or enrollment requirements. Please refer to Undergraduate Course Catalog or consult your advisor for information about pre-/co-requisite and enrollment requirements. These courses are noted with Footnote 1.

Regarding Double Majors and Minors

The Department of Political Science offers majors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy as well as minors in Political Science, International Studies, International Relations, National Security and Foreign Affairs, and International Public Policy. Courses for the majors and minors overlap significantly. Therefore, Political Science majors may not pursue multiple majors and/or minors within the department.

Acceptable Substitutions

SOC 3204 for PSCI 2024

Foreign Language Requirement

- Students who completed 3 years of a single foreign, classical, or sign language in high school have completed the requirement.
- Students who did not complete 3 years of a single foreign, classical, or sign language in high school may complete the requirement as follows:
  - Complete 2 years of a single foreign, classical, or sign language in high school plus an 1106 foreign language (e.g., FR, GR, SPAN) or the equivalent in college (these 3 hours do count toward the 120 required for graduation and calculate into the GPA) **or**
  - Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent in college (these 6 hours do **not** count toward the 120 required for graduation)

Religion and Culture

Our Website (http://liberalarts.vt.edu/rlcl/)

Overview

The Department of Religion and Culture critically investigates religion, culture, and their relationships by problematizing what is commonly considered self-evident, especially since these subjects are intrinsic to understanding the human condition both locally and globally. In our research, teaching, and engagement, we seek to craft and apply new forms of critical inquiry that advance integrative intellectual thought. These paths of inquiry inform our engagement with students, who become well prepared to understand complex transformations throughout their lives, whether they pursue graduate studies or other life trajectories.

The department offers undergraduate degrees in Religion and Culture (RLCL) and Humanities for Public Service (HPS) and minors in American Studies, Appalachian Cultures and Environments, Judaic Studies, Medieval and Early Modern Studies, Middle East Studies, Popular Culture, and Religion.

The department also offers two graduate certificates--one in Religion and the Public Sphere and the other in Material Culture and Public Humanities; and is a core member of the Alliance for Social, Political, Ethical, and Cultural Thought (ASPECT (https://liberalarts.vt.edu/departments-and-schools/alliance-for-social-political-ethical-and-cultural-thought.html)) Ph.D. program.

For more information on the department or any of our degree programs, please contact rlcl@vt.edu.

Religion and Culture Major (RLCL)

The Bachelor of Arts degree in Religion and Culture (RLCL) combines the strengths of the department in the areas of the humanities and study of religion in order to provide students with opportunities to examine several of the twenty-first century's most important global phenomena. Students completing this cutting-edge, one-of-a-kind degree will explore the impact of religious and cultural practices on politics, economics, the arts, and everyday life (including pop culture), as well as the impact of these practices on moral and ethical practices in today's world. Graduates will be prepared to contribute as employees and citizens to the state of Virginia, the United States, and indeed the world as all levels of society seek better ways to live and work together in the increasingly diverse contexts of the twenty-first century. Religion and culture shape the world and will continue to do so in dramatic and changing ways.

Students who choose this major will develop complex problem-solving skills, alongside critical thinking that will prepare them for a wide range of careers. The global focus of the major affords career opportunities in education, business, government, many private industries, and the non-profit sector. The major has a strong academic and career-advising component.

Humanities for Public Service Major (HPS)

The major in Humanities for Public Service gives intellectual weight to the Virginia Tech motto Ut Prosim ("That I may serve"). The course of study allows students the depth of knowledge to understand the religious and/ or cultural issues confronting modern society, both at home and abroad, while also allowing the flexibility to work directly with faculty on specialized topics ranging from environmental issues in Appalachia, to the impact of Artificial Intelligence on human flourishing.

Students in the major, Humanities for Public Service, build a strong foundation in humanistic learning about cultural and religious traditions with the aim of preparing for careers in public service. The major cultivates cultural awareness and critical thinking skills, familiarizing students with the ways that people have conceptualized, encoded, and reflected on human experience. Therefore it prepares them to sensitively and thoughtfully work for the public good. Requirements include selected courses in theory and practices, as well as a field study/ internship to give students direct experience that will benefit their future careers.

Study Abroad

Students are strongly encouraged to complete an approved study abroad program outside of the U.S. Study abroad programs are occasionally run by faculty in the department.

Honors College

Eligible students are encouraged to participate in the University Honors Program. Completing a degree "In Honors" is an excellent way for outstanding students to integrate the knowledge from several disciplines. Honors students have considerable flexibility in completing the degree requirements.

Double Majors

For information on earning a double major or second degree, contact the Department Chair. Since Religion and Culture major is flexible and dynamic, students are encouraged to earn a second major.

Religion and Culture Minors

The department offers the following minors. Please contact our undergraduate advisor, Benjamin WIley (wiley89@vt.edu), for more information.

- American Studies
- Appalachian Cultures and Environments
- Judaic Studies
- Medieval and Early Modern Studies
- Middle East Studies
- Popular Culture
- Religion

American Studies

American studies is an interdisciplinary field that draws upon a number of academic disciplines, including history, literature, and sociology, to consider relationships between culture and society in the United States as it is embedded in global processes and issues.

Appalachian Cultures and Environments

Appalachian Cultures and Environments is a Pathways minor supporting teaching, research, outreach, and service on topics pertaining to Appalachia in relation to pertinent transglobal issues. Courses focus on these issues from a critical regionalism perspective in which the relationship between these issues and region is considered problematic and open to investigation.

Judaic Studies

Endowed in 1996, the Malcolm and Diane Rosenberg Program in Judaic Studies offers students the opportunity to explore, examine, and critically engage the rich and multifaceted history, religion, and culture of the Jewish people. Judaic culture has significantly contributed to Western and other civilizations.

Medieval and Early Modern Studies

Medieval & Early Modern Studies fosters an interdisciplinary approach to the Medieval and Early Modern Worlds (roughly 300-1700 C.E.).

Middle East Studies

The interdisciplinary minor in Middle East Studies allows students to gain a broad understanding and appreciation of the languages, religions, and cultures of the Middle East and of the region's history and its place in international relations.

Popular Culture

The Minor in Popular Culture provides an understanding of the broadly shared cultures made possible by mass production. Popular culture includes all widely practiced and distributed expressions: news; entertainment; religion; sports; popular art; and styles of decoration, dress, and architecture.

Religion

By examining a diversity of traditions and viewpoints, a program in religious studies provides the resources for an intellectually responsible appraisal of one's own value commitments. A minor in Religion is part of a broad liberal arts education and may lead to graduate study in a variety of fields or to professional training in ministerial or social service vocations.

- Humanities for Public Service Major (p. 1109)
- Religion and Culture Major (p. 1110)

Chair: Rachel Scott
Professors: B. Britt, M. Gabriele, E. Satterwhite,[10] and R. Scott
Associate Professors: A. Abeysekara, A. Ansell, D. Christensen, Z. Ni,[10] and P. Seniors
Assistant Professors: A. Armstrong, C. Buckner, S. Patel, [10] and D. Polanco
Visiting Assistant Professor: R. Aras, and S. Sidky
Instructor: T. Edmondson
Post-Doctoral Associate: S. Plummer

Footnotes:

1 Award for Excellence in Undergraduate Advising
2 Academy of Teaching Excellence inductee
3 Wine Award recipient
4 Sporn Award recipient
5 Alumni Award for Extension Excellence
6 Alumni Award for Research Excellence
7 Alumni Award for Teaching Excellence
8 Academy of Faculty Service
9 Commonwealth of Virginia Outstanding Faculty Award
10 Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (APS)

APS 1704 - Introduction to Appalachian Studies (3 credits)
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 1704

APS 2124 - Music Traditions in Appalachia (3 credits)
Survey and study of music traditions in Appalachia. Investigation of the formal elements of this music, including instruments and musical terms and forms. Exploration of style as a reflection of many cultural influences. Study of the impact and development of these traditions in contemporary musical practices.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: MUS 2124

APS 2404 - Folk Cultures in Appalachia (3 credits)
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 2404

APS 2434 - The Cultural Politics of Music in Appalachia (3 credits)
Examines cultural, political, and social aspects of music in, of, and about Appalachia, including such commercialized and increasingly globalized products as "old-time," "bluegrass," and "country." Ways in which music contests and reproduces social relations of race, class, and gender. Role of migration and racial diversity in formation of Appalachian music. Economic significance of music, such as Virginia's The Crooked Road as a regional touristic undertaking.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

APS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 2974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

APS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 3124 - Societal Health in North America (3 credits)
Study of human health within and across a variety of geographic contexts in North America. Describe the health consequences of inequity and injustice within and across American contexts. Consider the roles of collectives, social movements, mutual aid, interdisciplinary thinking, power and social justice in addressing pathologies of power and working towards human well-being. Advocate a biosocial lens that considers the dynamic relationships between biology and environmental, social, geographic, and historical contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 3124

APS 3214 - History of Appalachia (3 credits)
Early settlement, religion, the pre-industrial economy, the coming of the coal and lumber industries, labor activism, politics, migration, and regional identity.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3214

APS 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

APS 3624 - Appalachian Literature (3 credits)
Appalachian literature from the region's beginnings to the present, including such diverse voices as women, Native American, Affrilachian, LGBTQ, and Latinx populations. Literary perspectives on the relationships between self, family, and community; place and displacement; and humans and the natural world. Analysis of stereotypes that have perpetuated inequity and displacement of power, as well as consideration of regional efforts to reclaim equity, power, place, and identity.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3624

APS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4034 - Appalachian Languages and Cultures (3 credits)
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4054

APS 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 4094, SOC 4094

APS 4414 - Issues in Appalachian Studies (3 credits)
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse.
Prerequisite(s): HUM 1704 or APS 1704
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 4414

APS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4974H - Independent Study (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

APS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

APS 4994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (HUM)

HUM 1024 - Introductory Humanities: Great Books (3 credits)
An introduction to the humanities through the topic of "Great Books." Students will closely analyze primary canonical texts from the West and from the global south. Political, religious, philosophical, and literary works by important writers and communities from across the globe will be explored to understand the human condition and self-formation. Such engagement with primary texts will be put into the context of larger topics such as class, race, and gender in addition to colonialism, decolonialism, and postcolonial modernity.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: CRIM 1054, RLCL 1054

HUM 1324 - Introductory Humanities: The Modern World (3 credits)
The shifts in thought and values during the nineteenth and twentieth centuries in the global imagination, including issues of commerce, scientific inquiry, industrialization, nationalism, war, labor, gender, class differences, race, and the beginnings of postmodernity. Emphasis on interpretive and analytic skills in terms of reading, discussing, and writing about the interrelationships among the arts, literature, philosophy, history, religion, and science, and their contributions toward shaping the values and aspirations of the age, including global contexts and Asian cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1504 - Introduction to Popular Culture (3 credits)
The development and formation of the category of popular culture. Competing theories and methods for analyzing popular culture. Activities, objects, and ideas included under the rubric of popular culture. Critical thinking about the production of popular culture in relation to race, gender, class, and other forms of human difference.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 1504

HUM 1604 - Introduction to Humanities and the Arts (3 credits)
Explores the written, visual, and performing arts of selected periods and cultures, setting them in the context of their times. Study of these periods linked with overarching questions of cultural encounters, interactions, and negotiations. Introduces principles of each art form as well as the means of appreciation. Students taught methods in researching, writing, and presenting on these art forms.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 1704 - Introduction to Appalachian Studies (3 credits)
Introduces students to the history of the Appalachian region from European contact to the present. Traces the idea of Appalachia by tracing ways in which Americans have imagined the region over time. Explores humanistic problems of cultural identity, race and ethnicity, place and globalization, and impacts of natural resource extraction.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 1704

HUM 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 1984A - Special Study (3 credits)
Pathway Concept Area(s): 1A Discourse Advanced
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 2104 - Oral Traditions and Culture (3 credits)
Examination of the worlds great oral traditions, both ancient and contemporary. Emphasis on performance contexts, relationships among multicultural traditions, including American Indian oral traditions, and the relationships among orality, literacy, technology, media, and culture.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AINS 2104

HUM 2204 - The Creative Process (3 credits)
Explores ways in which creativity and design can be understood historically as well as understood and practiced in a classroom setting. Subjects include any or all of the following: theories of creativity; traditions associated with understanding and making several kinds of art; studying artworks from different cultural backgrounds, working with the limitations and possibilities inherent in design projects, and examining how and why they were created; and preparing final creative projects for classroom presentation.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

HUM 2404 - Folk Cultures in Appalachia (3 credits)
Examination of the expressive genres and cultural processes of communities in Appalachia. Documentation of art and skill in everyday life, including material culture (e.g., foodways, architecture), customary behavior (e.g., music, ritual, occupational practice), and verbal art (e.g., narrative, speechplay), and analysis of how people have used these forms to shape social identities, physical spaces, and power relations.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 2404

HUM 2504 - Introduction to American Studies (3 credits)
Methodology and tools of American studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2504

HUM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 3034 - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3034

HUM 3034H - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3034H

HUM 3204 - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3204

HUM 3204H - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3204

HUM 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, SOC 3464, UAP 3464

HUM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4104 - Explorations in Advanced Humanities Topics (3 credits)
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature, philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: RLCL 4104

HUM 4124 - Topics in Culture (3 credits)
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the cultural of the nineteen sixties. Course may be repeated with different course content for up to 6 credits. Pre: Junior or Senior standing.
Prerequisite(s): SOC 1004 or SOC 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: SOC 4124

HUM 4414 - Issues in Appalachian Studies (3 credits)
Research conducted by students on issues relevant to local or regional sustainability in contemporary Appalachia on contemporary environmental and community issues. Focus on environmental justice ethical issues expressed in or created by various forms of discourse.
Prerequisite(s): HUM 1704 or APS 1704
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4414

HUM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

HUM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (JUD)

JUD 1105 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HEB 1105

JUD 1106 - Elementary Modern Hebrew (3 credits)
Introduction to speaking, listening, reading, and writing the modern Hebrew language. Emphasis on developing proficiency in practical language use, comprehension and cultural competency. 1105: Basic tasks such as greetings, counting, and simple requests; for students with no prior knowledge of the language. 1106: More advanced tasks like asking directions, expressing personal preferences, or making purchases.
Prerequisite(s): JUD 1105
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HEB 1106

JUD 2134 - Judaism: A Survey of History, Culture, and Heritage (3 credits)
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2134

JUD 2414 - Hebrew Bible/Old Testament (3 credits)
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the Hebrew Bible (Old Testament).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2414

JUD 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 3404 - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament and beyond.
Prerequisite(s): REL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3404

JUD 3404H - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 3404H

JUD 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3494, RLCL 3494

JUD 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political economy, etc.
Prerequisite(s): JUD 2134 or PSCI 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3544, RLCL 3544

JUD 4424 - Advanced Topics in Jewish Culture, History and Thought (3 credits)
Selected topics in Jewish culture, history and thought. Possible topics includes: the philosophy of Maimonides, Spinoza or Buber, or a course dedicated to one of the following topics: Kabbalah, Hasidism, The American Jewish experience in the first half of the 20th century, and Oriental Jewish art and folklore. Two JUD courses or senior standing required. Alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

JUD 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

JUD 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (RLCL)

RLCL 1004 - Introduction to Religion and Culture (3 credits)
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1004H - Intro to Religion & Culture (3 credits)
This course introduces students to foundational concepts and debates within the humanities and social sciences by studying one of a rotating set of themes (e.g. love, evil, apocalypse) located at the intersection of religion and culture. Emphasis on cultural diversity, historical transformation, interdisciplinary inquiry, problem-solving and the application of academic discussions to everyday life situations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1014 - World Religions (3 credits)
Formation of the category of world religions in the modern West. Basic worldviews, embodied practices, and traditions included under the rubric of world religions. The encounter of and mismatch between traditions identified as world religions and the category of world religions as an instrument of colonialism and imperialism.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1024 - Judaism, Christianity, and Islam (3 credits)
Nature of religion and the analysis of it from an academic perspective. Basic tenets of Judaism, Christianity, and Islam, including their manifestations in the United States and their involvement in critical issues in a global context Interpretation of key texts from various historical and cultural contexts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1034 - Religion and the Modern World (3 credits)
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1034H - Religion and the Modern World (3 credits)
Modern challenges to traditional religion and responses to these challenges, including: religion as an object of critique; law, sovereignty, and religion; religion, gender, and race; religion, science, and technology; religion and media presentations.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1044 - Religious Ethics (3 credits)
Influential representative social and religious ethical perspectives from ancient Greek philosophers to the present; ethical reasoning on current pressing and perennial social issues - bioethics, sexuality, family, poverty--based on historical and ethical analysis of case studies; theoretical assumptions about morality as the relation between living a virtuous life and performing ethical duties.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: CRIM 1054, HUM 1054

RLCL 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, PSCI 1084, SOC 1084

RLCL 1134 - The Ancient Mediterranean World (3 credits)
Ancient cultures of the Mediterranean world with a focus on their embodiments in the arts, literature, history, philosophy, and religion. Emphasis on Greek, Hellenistic and Roman cultures, their interrelationships with each other and their historical, cultural, material and intellectual encounters with contemporary Mediterranean cultures as well as their influence on later and modern cultures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 1134

RLCL 1214 - The Medieval World (3 credits)
Introduction to Europe and the Mediterranean world in the period between antiquity and the European encounter with the Americas. Investigation of the arts, literature, philosophy, and history of the period in the Christian, Jewish, and Islamic traditions and the multiple types of encounters that those communities experienced. Analysis of the impact the medieval world continues to have on the modern West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1504 - Introduction to Popular Culture (3 credits)
The development and formation of the category of popular culture. Competing theories and methods for analyzing popular culture. Activities, objects, and ideas included under the rubric of popular culture. Critical thinking about the production of popular culture in relation to race, gender, class, and other forms of human difference.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 1504

RLCL 1904 - Religion and Culture In Asia (3 credits)
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories religion and culture and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 1904H - Religion and Culture in Asia (3 credits)
Historical and geographical overview of diverse religious/cultural traditions in Asia, such as Hinduism, Buddhism, Sikhism, Confucianism, Daoism, and Shinto. Investigation of the categories religion and culture and their interactions in Asia. Examination of different methodological and interdisciplinary approaches and their integration, with emphasis on critical thinking about the complexities of studying religion and culture in Asia. Asia on a global stage, including Western views of Asia and Asian views of the West.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2004 - Case Studies in Religion and Culture (3 credits)
Significant case studies in the study of religion and culture with an emphasis on influential and emerging research. Focused engagement with humanities and social sciences research grounded in analysis, comparison, and evaluation of relevant case studies.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2054 - Ethnography: Studying Culture (3 credits)
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2054

RLCL 2104 - Greek New Testament (3 credits)
Readings from the New Testament in Greek, with attention to grammatical analysis, historical background and other clues interpretation. May repeated with different content for a maximum of 9 credits.
Prerequisite(s): GR 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours
Course Crosslist: GR 2104

RLCL 2124 - Religion in American Life (3 credits)
Understanding and integrating source materials for the study of religion in American life. Genealogy of religion and culture in America (USA). Changes and transformations in religious beliefs and practices and their influences on American life. Debates about religion and culture. Entanglements of religion, politics, race, ethnicity, and law.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2134 - Judaism: A Survey of History, Culture, and Heritage (3 credits)
Introduction to the academic study of Judaism; a variety of scholarly approaches to Jewish textual and cultural sources, including the Hebrew Bible, rabbinic literature, and diverse contemporary cultural, religious, and social expressions. Emphasis on developing skills in critical thinking, reading, and writing about Judaism as a way of understanding the beliefs, philosophies, and histories of global Jewish communities past and present.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 2134

RLCL 2144 - African Religions (3 credits)
The role of religious (or belief) systems in African societies, especially the three predominant religious traditions in Africa: the so-called African Traditional Religious, Islam, and Christianity; the universe of religious systems and religious experiences and processes of Africa, in particular, Sub-Saharan Africa; critical examination of the mythic stature of Africas religions within Western cultural (and scholarly) world views and institutions.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2144

RLCL 2204 - Race and Gender in Religion and Culture (3 credits)
Influence of race and gender on religion and culture. Overview of approaches to categories of diversity, particularly race and gender, in religious and cultural traditions. Utilization of humanistic and social scientific approaches to investigate geographically variable historical and/or contemporary case studies.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2204, WGS 2204

RLCL 2324 - Islam (3 credits)
Addresses the rise of Islam under the Prophet Muhammad in Arabia, the development of Islam in the Middle Ages, and its resurgence in the 20th century. Issues of geographical, temporal, and ideological diversity, and critical thinking about representations of Islam in the West. Islamic orthodoxy addressed by examining the question of who represents Islam, when, and how.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2374 - Gods and Kings in Premodern India (3 credits)
History of India from pre-historical times to approximately 1700, with particular focus on the interplay between religion and politics. Emphasis on sources for and interpretations (historiography) of early Indian history. Literary versus archaeological record of pre-historic India, the earliest empires and rulers, and impact of the Islamic and wider world on India. Legacies of ancient and medieval India in the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2374

RLCL 2384 - Gandhi in the Making of Modern India (3 credits)
History of India since approximately 1700, with particular focus on Gandhis influence on modern India and the world. Emphasis on sources for and interpretations (historiography) of modern Indian history. Examination of pre-colonial and colonial pasts and legacies. Exploration of Gandhis role in political, social, cultural, and religious movements of the early 20th century, and Gandhis legacy in the independent states of South Asia and the contemporary world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2384

RLCL 2394 - Tofu to Tikka: Food in Asian History (3 credits)
Exploration of the evolution and alterations of food and cuisines throughout Asian history. Examination of the economic, geographical, political, philosophical/religious, and social underpinnings of food in premodern Asian societies; influence of the Columbian Exchange of Asian and global cuisines; Euro-American imperialism's impact on food and society in Asia and in the European and American metropoles; emergence of national cuisines in Asia; and Asian food in the post-colonial diaspora.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2394

RLCL 2414 - Hebrew Bible/Old Testament (3 credits)
Introduction to the academic study of the Hebrew Bible (Old Testament), including its contents, contexts, major themes, and reception; a variety of scholarly approaches, including historical-critical, literary, ethical, and gender studies methods. Emphasis on developing skills in critical thinking, reading, and writing about the Hebrew Bible (Old Testament).
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 2414

RLCL 2424 - New Testament (3 credits)
Introduction to the academic study of the New Testament, including gospels, Pauline materials, theological themes, and sources on the emerging church. A variety of scholarly approaches to the New Testament texts and contexts, including historical-critical, redaction critical, and literary methods. Emphasis on developing skills in critical thinking, reading, and writing about the New Testament and the ancient Mediterranean world as a way of understanding the religion and history of early Christianity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 2434 - Legends of King Arthur (3 credits)
Introduction to legends of King Arthur, including stories, novels, and films from a wide historical timespan. Tales of knights, kings, and fair maidens that have entertained generations and irrevocably shaped cultural values surrounding gender relations, justice, violence, and the use and abuse of power. Analysis of individual texts and broader consideration of the Arthurian tradition during key literary-historical periods from the medieval era to the present.
Prerequisite(s): ENGL 1106 or COMM 1016
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2434

RLCL 2444 - Greek and Roman Myth (3 credits)
Surveys ancient Greek and Roman mythology. Provides students with an introduction to selected myths from ancient Greek and Roman literature, including appropriate historical background information. Familiarizes students with how theories of myth have been applied to individual stories and how such mythological tales have been received by authors and artists in subsequent cultures. Explores the interaction and interdependence of mythological tales from different cultures and perspectives. In English.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CLA 2444, ENGL 2444

RLCL 2464 - Religion and Science (3 credits)
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 2464

RLCL 2474 - Religion and Violence (3 credits)
Investigation of the categories of religion and secularity as they apply to war and peace. Analysis of episodes from both past and present in which religion seems to have played a role. Introduction to research skills related to the study of religion and violence, building from theoretical and historical considerations.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2474

RLCL 2484 - Religion and Politics (3 credits)
Investigation of religion and politics as distinct categories in different times and places. Analysis of episodes from both past and present in which religion and politics have come together, or have been kept apart. Examination of the roles religion and politics play in the modern world and how they impact the lived experience of diverse populations both in the United States and throughout the world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2484, PSCI 2484

RLCL 2504 - Introduction to American Studies (3 credits)
Methodology and tools of American Studies, with a focus on developing analytic skills to assess discourse across varied media. Interdisciplinary investigation of histories, politics, cultures, and beliefs in the Americas, including the impacts of encounter and exchange. Intensive study of a specific topic or period.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 2504

RLCL 2514 - Asian American Experience (3 credits)
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter-generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 2514

RLCL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 3014 - Women and Gender in Islam (3 credits)
An examination of women and gender in Islam from a variety perspectives including Muslim women in Islamic history, normative constructions of the role of women in Islam, and womens roles in contemporary Muslim societies. Understanding of women in classical Islam; feminist and reformist approaches; and Western constructions of the rights of women if Islam.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 3014

RLCL 3024 - Religion and Literature (3 credits)
Read works from world literature, guided by selected critical readings. Compare/contrast diverse models of religion and literature. Study how modernity has impacted traditions of religion and culture. Interpret literary texts that draw from multiple religions. Analyze religion-literature controversies in a range of social, cultural, political contexts. Synthesize sources of multiple media, formats, and contexts.
Pathway Concept Area(s): 1A Discourse Advanced, 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3024

RLCL 3034 - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3034

RLCL 3034H - Theories of Popular Culture (3 credits)
Examination of theories for understanding the ways in which popular objects and practices (such as television programs, films, or attending sporting events) represent, maintain, and contest societal norms, including norms regarding gender and sexuality, race and ethnicity, and class and place, with an emphasis on the United States.
Pathway Concept Area(s): 1A Discourse Advanced, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3034H

RLCL 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3144, SOC 3144

RLCL 3204 - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3204

RLCL 3204H - Multicultural Communication (3 credits)
Exploration of communication in and among various cultural groups through an examination of communicative practices, registers, discourse, and performance. Emphasis on understanding cultural differences and similarities in the different styles and stances in communication and their meanings to participants.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 3204

RLCL 3214 - Religion and Culture in India (3 credits)
Interdisciplinary examination of the genealogy of Indian religions (including Hinduism, Buddhism, Jainism, and Sikhism) through anthropological, literary, historical, and textual source materials. Colonial construction and reform of these religions according to modern, universal European ideas of religion; how European notions of the modern nation-state, law, and religious tolerance, and European concepts of self, autonomy, community, (univocal) language, and multiculturalism impacted Indian religions. Pre-modern versus modern notions of tradition and power in Indian religions. Concepts of secularism, gender, race, conversion, caste, and religious-political identity.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3224 - Religion and Culture in China and Japan (3 credits)
Premodern model of Chinese and Japanese religions: interactions of various traditions (e.g. Confucianism, Buddhism, Daoism, Shinto, and folk); inseparability of religion, culture, society, and politics. Modern reinventions of religion in China and Japan in the late nineteenth and early twentieth centuries. Contemporary issues such as state-religion relations in East Asia, religions of China and Japan in America, East Asian religions and globalization.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3404 - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3404

RLCL 3404H - Torah and Tradition (3 credits)
Detailed study of the first five books of the Bible, known as the Torah or Pentateuch. Scholarly approaches will include historical-critical research; comparative mythology; form and canon criticism; gender and literary studies; and the reception of these books in the Hebrew Bible, the New Testament, and beyond.
Prerequisite(s): RLCL 2414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3404H

RLCL 3414 - Jesus in Earliest Christianity (3 credits)
Literary survey of the various representations of Jesus of Nazareth in canonical and apocryphal Christian literature of the first four centuries. Perspectives on Jesus and the interpretive authority involved in producing such variety. Ancient and modern interpretive frameworks for understanding the person and legacy of Jesus in earliest Christianity, including historical-critical frameworks, redaction criticism, genre criticism, and other literary methods. Analyses of modern religious/political discourses as continuations of ancient theological debates. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3424 - Orthodoxy and Heresy in Early Christianity (3 credits)
Literary survey focusing on the diversity of Christian beliefs in the first four centuries. Highlights a variety of theological debates and the historical and cultural contexts involved in the eventual production of a Christian orthodoxy, over and against so-called heresy. The history and content of early Christian texts, both canonical and apocryphal. Ancient and modern interpretive frameworks for understanding the variety and diversity of earliest Christian beliefs, including historical-critical frameworks, comparative reading, source criticism, and other literary methods. Emphasis on developing skills in critical thinking and close reading of early Christian texts as a means of understanding the religion(s) and histories of the earliest Christians.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 3454 - Philosophy of Religion (3 credits)
A consideration of religious belief and its justification with attention to such philosophical issues as the nature and existence of the Judeo-Christian-Muslim God, proofs for the existence of God, the problem of evil, a religious basis for ethics, the nature of faith, and the variety of religious beliefs.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHIL 3454

RLCL 3494 - The Holocaust (3 credits)
This course provides a historical account, a psychological analysis, and an occasion for philosophical contemplation on the Holocaust. We will examine the deliberate and systematic attempt to annihilate the Jewish people by the National Socialist German State during World War II. Although Jews were the primary victims, Gypsies, people with disabilities, homosexuals, Jehovahs Witnesses and political dissidents were targeted; we will discuss their fate as well. The class will be organized around the examination of primary sources: written accounts, photographic and film, personal testimony.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3494, JUD 3494

RLCL 3504 - The Age of The Crusades (3 credits)
The origins and development of religious violence examined from an interdisciplinary and cross-cultural perspective; the place of that phenomenon in medieval society. Christianity, Islam, Judaism and their interactions in the medieval world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3504

RLCL 3544 - The State of Israel: A Political History (3 credits)
This course provides a survey on the political history of the State of Israel and highlights major themes uniquely characterizing the specific events surrounding its establishment and its first 50 years of existence. Additionally, the course will add a comparative dimension by using the political history of Israel as a case study to discuss major themes in political science such as democracy, government, political, economy, etc.
Prerequisite(s): JUD 2134 or PSCI 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: JUD 3544, PSCI 3544

RLCL 3644 - Religion in the Middle East (3 credits)
Critical issues in religion in the Middle East. Competing methods for analyzing religion in the Middle East. Key concepts relating to religion and inter-religious relations in the Middle East such as minority, majority, tolerance, citizenship, and family law. Critical thinking about the relationship between Islam and other religions with particular reference to Muslim-Jewish and Muslim-Christian relations.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARBC 3644, IS 3644

RLCL 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3884, SOC 3884

RLCL 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4014 - Religion and the Public Sphere (3 credits)
Debates about the resurgence of religion in the modern world. Complexities involved in defining religion. Social-scientific, phenomenological, and cultural approaches to the study of religion. Theories concerning what role religion should play in the public sphere. Theories about secularism, secularization, and the differentiation between religion and politics.
Instructional Contact Hours: (3 Lec, 3 Crd)

RLCL 4024 - Sociology of Religion (3 credits)
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4024

RLCL 4104 - Explorations in Advanced Humanities Topics (3 credits)
In-depth study of special interdisciplinary topic. Topics vary but involve a close and extensive study of the interrelationship between cultural ideas and their expressions in several of the following forms: literature, philosophy, religion, art, music, drama, material culture, and popular culture. May be repeated with different topics, for a maximum of 9 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HUM 4104

RLCL 4324 - Topics in Religion and Culture (3 credits)
Selected topics from the religions of the world such as time and the sacred, preliterate religions, women and religion, religion and science, mysticism. May be taken three times for credit with different topics.
Prerequisite(s): RLCL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

RLCL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

RLCL 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Humanities for Public Service Major

Code	Title	Credits
Degree Core Requirements		
RLCL 1004	Introduction to Religion and Culture	3
RLCL 1034	Religion and the Modern World	3
RLCL 2004	Case Studies in Religion and Culture	3
HUM 2504	Introduction to American Studies	3
RLCL 3024	Religion and Literature	3
HUM 3204	Multicultural Communication	3
RLCL 4324	Topics in Religion and Culture	3
Subtotal		21
Major Requirements		
Context/Competency Electives		
Select two of the following: [1]		6
HUM 1704	Introduction to Appalachian Studies	
HUM 3034	Theories of Popular Culture	
RLCL 1014	World Religions	
RLCL 1024	Judaism, Christianity, and Islam	
RLCL 2204	Race and Gender in Religion and Culture	
RLCL 2514	Asian American Experience	
RLCL 2464	Religion and Science	
RLCL 3644	Religion in the Middle East	
AINS 3684	Indigenous Peoples and World Politics	
JMC 3254	Media and Politics	
FREC 2554	Leadership for Global Sustainability	
HIST 2275	African-American History	
or HIST 2276	African-American History	
PSCI 2054	Introduction to World Politics	
Applied Courses		
Select two of the following:		6
HUM 1504	Introduction to Popular Culture	
HUM 3464	Appalachian Communities	
APS 4094	Appalachian Community Research	
RLCL 1044	Religious Ethics	
RLCL 2054	Ethnography: Studying Culture	
RLCL 2484	Religion and Politics	
RLCL 3144	Language and Ethnicity in the United States	
RLCL 4014	Religion and the Public Sphere	
HIST 3754	Public History	
PHIL 2304	Global Ethics	
PSCI 3414	Public Administration	
STS 2444	Global Science and Technology Policy	
TA 3604	Arts Management	
RLCL 4964	Field Study [2]	3
or HUM 4964	Field Study	
or APS 4964	Field Study	
Subtotal		15
Elective Courses		
Select 39-42 elective credits		39-42
Subtotal		39-42
Pathways to General Education [3] [4]		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6

Pathways Concept 4 - Reasoning in the Natural Sciences	
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)	6
Pathways Concept 5 - Quantitative and Computational Thinking	
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120-123**

[1] Only 3 credits can be at the 1000-level; at least 3 credits must be APS, HUM, or RLCL).
[2] An advisor-approved study abroad program can be substituted.
[3] May not be met with Degree Core courses. May be met with approved Context/Competency elective courses.
[4] 3 credits; may overlap with another Pathways concept.

Satisfactory Progress Toward a Degree

1. Completion of RLCL 1004 Introduction to Religion and Culture and 12 credits in the major by the semester in which the student has attempted 60 semester hours.
2. GPA of 2.0 in departmental courses by the semester in which the student has attempted 96 semester hours (including transfer, AP, advanced standing, and credit by exam).

Note: Some courses listed on this checksheet have prerequisites. Be sure to consult the Undergraduate Course Catalog and /or check with your advisor.

Graduation Requirements

1. Minimum of 120 credits for the degree. Total Credits Completed:
2. Minimum of 30 credits in departmental courses (maximum of 51 credits). Depart. Credits Completed:
3. Overall GPA and in-major GPA of 2.0 or above.

Note: In-major GPA is based on all courses taken under I and II.

For more information about the B.A. in Humanities for Public Service, contact Ben Wiley at (540) 231-5033 or wiley89@vt.edu.

Foreign Language Requirement

University and CLAHS Admissions Foreign Language Requirement

1. 3 years of a single foreign language in high school or
2. 2 years of a single foreign or sign language in high school, plus 1106 or equivalent in college (these 3 hours count toward the 120 required for graduation and should be listed as an elective course in VII below) or
3. if fewer than 2 years of a single foreign language in high school must complete 1105-1106 or the equivalent in college (these 6 hours do not count toward the 120 required for graduation)

Religion and Culture Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
RLCL 1004	Introduction to Religion and Culture	3
RLCL 1034	Religion and the Modern World	3
RLCL 2004	Case Studies in Religion and Culture	3
HUM/RLCL 2504	Introduction to American Studies	3
RLCL/ENGL 3024	Religion and Literature	3
HUM/RLCL 3204	Multicultural Communication	3
RLCL 4324	Topics in Religion and Culture	3
Subtotal		21
Major Requirements		
Select 12 credits from APS, HUM, JUD, or RLCL courses, at least 6 of which must be at the 3000-level or above. Note: Some of the 3000-4000-level departmental courses have prerequisites.		12
Subtotal		12
Elective Courses		
Select 42-45 credits of electives		42-45
Subtotal		42-45
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		

Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) (may overlap w/ another PW concept)	3
Subtotal	45
Total Credits	**120-123**

Satisfactory Progress Toward a Degree

1. Completion of RLCL 1004 Introduction to Religion and Culture and 12 credits in the major by the semester in which the student has attempted 60 semester hours.
2. GPA of 2.0 in all APS, HUM, JUD, and RLCL courses listed under Degree Core and Major Requirements by the semester in which the student has attempted 96 semester hours (including transfer, AP, advanced standing, and credit by exam).

Note: Courses with prerequisites are noted. There are no hidden pre-requisites.

Graduation Requirements

1. Minimum of 120 credits for the degree.
2. Minimum of 33 credits in departmental courses.
3. Overall GPA and in-major GPA of 2.0 or above.

Note: In-major GPA is based on all APS, HUM, JUD, and RLCL courses taken under Degree Core and Major Requirements.

For more information about the B.A. in Religion and Culture, contact Ben Wiley at (540) 231-5033 or wiley89@vt.edu (avillar@vt.edu).

University and CLAHS Admissions Foreign Language Requirement

1. 2 years of a single foreign or sign language in high school **or**
2. 2 years of a single foreign or sign language in high school, plus 1106 or equivalent in college (these 3 hours count toward the 120 required for graduation and should be listed as an elective course) **or**
3. if fewer than 2 years of a single foreign language in high school must complete 1105-1106 or the equivalent in college (these 6 hours do not count toward the 120 required for graduation)

School of Communication

Our Website (https://liberalarts.vt.edu/departments-and-schools/school-of-communication.html)

Overview

The School of Communication offers five undergraduate majors: Advertising, Communication, Multimedia Journalism, Public Relations, and Sports Media and Analytics. These majors lead to a B.A. in Communication. The five majors, each grounded in a strong liberal arts curriculum, prepare students for careers in journalism, broadcasting, digital media production, public relations, advertising, sports media, business, public service, government, and professional specializations, such as law. Coursework in the school focuses on strategic, theoretical, and practical application of message creation, delivery, and analysis. Graduates from each major are prepared to apply their skills immediately in various professional settings or continue their studies in graduate school.

The school is organized into three curriculum divisions: Communication Studies (CMST), Journalism and Mass Communication (JMC), and Public Relations and Advertising (PR/ADV). Each division is responsible for specific majors. The three divisions share responsibility for the school's core (COMM) curriculum. The Communication Studies division coordinates the school's Communication Skills and Public Speaking offerings. The Public Relations curriculum is certified by the Public Relations Society of America.

Majors

Advertising (ADV) - This major prepares students to craft and deliver persuasive messages through paid media. Coursework explores theories, practice, and ethics of advertising. Students learn about market research, consumer behavior, account planning, media buying, brand storytelling, copy design and production, and campaign evaluation. Major courses come from the School of Communication, Pamplin College of Business, and School of Visual Arts.

Communication (COMM) - This major develops human-interaction strategies and skills relating to decision making, influence, and information exchange in face-to-face, public, and organizational contexts. As a graduate, you might consider careers in business, health, civic engagement, law, education, and ministry.

Multimedia Journalism (MJ) - This major prepares students for careers at newspapers, magazines, broadcast and cable outlets, and online news operations. The lines that separate these specialties have blurred as delivery media have converged. Courses offer both practical skills and theory as they address history, law and ethics, current controversies, and opportunities in the changing news business.

Public Relations (PR) - This major emphasizes both skill and management functions of public relations through theoretical and practical applications. Public relations spans media, organizational, corporate, and political contexts. The discipline includes investigation and analysis of public relations situations (e.g., crises, successes), message production and campaign planning, writing and presentation, and evaluation of public relations strategies. Public relations permeates many areas of corporate, nonprofit, and political work, so this major provides students a foundation for many different career paths. The public relations curriculum is certified by the Public Relations Society of America.

Sports Media and Analytics (SMA) - This major prepares students to produce and deliver sports news, consider ways to promote the sports industry, and analyze data related to sports accomplishments, fan participation, and social media. Employment opportunities are varied and include sports reporting; public relations for sports venues, teams, or athletes; and promotional work for businesses that support the fans.

Major Requirements

The curriculum for each major is designed to provide foundational and developmental courses along with major-specific study. Students are introduced to concepts early in the undergraduate career, and the

curriculum allows them to build knowledge and skills as they work on increasingly complex tasks. Students develop skills in written, spoken, and visual communication. At the foundational level, students in every major are required to take the same introductory courses.

Minor Requirements

The School of Communication offers three undergraduate minors: Advertising, Health Communication, and Strategic Communication.

Advertising This 18-credit minor introduces students from outside mass communication disciplines to basic principles of paid persuasive communication. The minor requires students to earn 15 credits from divisions within the School of Communication and 3 credits from the Marketing Department in the Pamplin College of Business.

Health Communication This 21-credit multidisciplinary minor exposes students to core Pathways learning outcomes and builds knowledge about health communication. Four introductory requirements, two mid-level electives, and a capstone course consider theoretical and practical tools used to promote and affect health behavior change.

Strategic Communication This 18-credit multidisciplinary Pathways minor is open to majors from across the university and is especially appropriate for students in business or science, technology, engineering, and mathematics disciplines. Courseworkfour introductory requirements, one elective, and a capstone courseshows students how strategic communication works in a variety of industries. Few jobs have no communication components.

Specific course requirements for each minor are explained on checksheets. These three minors are not open to students in the Advertising, Communication, Multimedia Journalism, Public Relations, or Sports Media and Analytics majors.

Satisfactory Progress Toward the Degree

University policy requires that students demonstrate their progress toward the degree by meeting minimum requirements. A student will be certified as making satisfactory progress toward a degree by meeting the following requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first three classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first six classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first eight classes (24 credits) in the major.
- Overall GPA: 2.0
- Major GPA: 2.0

Students who fall below the standard for either the overall GPA or the major GPA will have one semester to regain the required GPA standards. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in any School of Communication and Digital Media major.

Freshmen and External Transfers into Communication

Incoming freshmen and students enrolled at other institutions should follow directions for application as shown on the Admissions website.

Internal Transfers into Communication

Students enrolled in other Virginia Tech majors who wish to transfer into the School of Communication may use the online system for application.

School Website and Contact

Please see the school website for more information about majors and minors:
https://liberalarts.vt.edu/departments-and-schools/school-of-communication.html
Contact: comm@vt.edu

- Advertising Major (p. 1119)
- Communication Major (p. 1121)
- Multimedia Journalism Major (p. 1123)
- Public Relations Major (p. 1125)
- Sports Media and Analytics Major (p. 1127)

Director: John C. Tedesco
Associate Director: Hannah S. Deuyour
Director of Undergraduate Programs: Brandi A. Quesenberry
Director of Graduate Studies: M. Cayce Myers
Professors: C. Evia, J. A. Kuypers, M.C. Myers, and J. C. Tedesco
Professors of Practice: D. Jefferies, R. J. Reed, and W. B. Roth
Associate Professors: M. A. Duncan, R. L. Holloway, A. Holz, M. A. Horning, N. J. Logan, N. Mielczarek, S. A. Smith, B. A. Watkins, and C. L. Woods
Associate Professor of Practice: C. L. Brown and J. Combs
Assistant Professors: M. Zimmerman
Assistant Collegiate Professor: H.S. Deuyour
Assistant Professor of Practice: A. Amey
Senior Instructors: B. A. Quesenberry and S. J. Robinson
Advanced Instructors: C. H. Boor, D. Conner, B. W. Howell, D. M. Jenkins, K. M. McAllister, L. S. Purcell, S. C. Stinson, and N. Sowder
Instructors: T. H. Bennett, M. Cassady, E. Johnson, C. Thomas, A. Widgeon and J. M. Woolly

Undergraduate Course Descriptions (ADV)

ADV 2034 - Visual Communication Strategies (3 credits)
Concepts and techniques of visual storytelling for corporate and commercial communication through paid, earned, shared, and owned media. Design and production of visual messages for delivery through print, photography, videography, and online channels. Analysis of effective visual communication in advertising and public relations campaigns. Ethical consideration of visual communication choices. Pre: Sophomore standing
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

ADV 2134 - Introduction to Health Communication (3 credits)
Introduction to health communication with a focus on current issues and perspectives, including patient-provider communication, cultural conceptions of health and illness, media portrayals of health, communication in health organizations, health communication theories, information technologies in health communication, ethical considerations, and health promotion campaigns.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ADV 3004 - Advertising Copywriting and Brand Storytelling (3 credits)
Writing advertising messages for print, broadcast, and online media. Basic design and strategic messaging for visual, verbal, and video storytelling. Promotional and sales appeals for products, services, and causes. Theories of image creation and brand identity. Legal and ethical considerations in paid media.
Prerequisite(s): COMM 2024 and MKTG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ADV 3014 - Account Planning and Media Buying (3 credits)
Account planning and media buying in an agency environment. Business and market analysis for advertising clients. Research and assessment strategies for paid-media messages. Management, motivation and persuasion theories in programming. Data analysis, creative briefs, and copy testing. Selection and scheduling of media buys to deliver promotional messages through appropriate communication channels to target audiences efficiently and effectively. Legal and ethical considerations in advertising planning and management.
Prerequisite(s): MKTG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ADV 3024 - Ethics and Social Responsibility in Advertising (3 credits)
Social and ethical issues in commercial and corporate speech. Government regulations of advertising. Propaganda in business, social, and political communication through history. Influence of advertising on culture, social movements, and gender identity.
Prerequisite(s): MKTG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

ADV 3034 - Topics in Public Relations and Advertising (3 credits)
Selected topics in public relations and advertising. Emphasis on theoretical, practical, or ethical issues in selected contexts. May be repeated 1 time with different content for a maximum of 6 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PR 3034

ADV 4324 - Issues in Health Communication (3 credits)
Study of issues related to the theory and practice of health communication, including interpersonal, public, organizational, political, and cultural. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

Undergraduate Course Descriptions (CMST)

CMST 2034 - Visual Media (3 credits)
Planning and production of visual messages for delivery through print, photography, videography, websites, social media, and mobile applications. Theories and principles of visual communication important to individuals working in communication jobs. COURSE FEE $59. Pre: Sophomore standing
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 2064 - The Tradition of Rhetoric and Societal Change (3 credits)
Key theories and figures in rhetoric over the past 2,500 years. Evolution of rhetorical and critical perspectives in communication. Dynamic, critical nature of persuasive communication. Methodological approaches to rhetorical criticism, ethics of message creation, communication contexts, emerging perspectives, and impact of changing culture/society on rhetorical theory.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3024 - Digital Publishing (3 credits)
Study and contemporary practices in digital publishing aimed at multichannel distribution for diverse audiences. Principles, standards, workflows, technologies, and strategies for ethical and accessible design and automation of content for Web, mobile, print, multimedia, and voice environments.
Prerequisite(s): COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3044 - Oral Communication Center Practicum (1 credit)
Focus on peer pedagogy in a communication center to support development of oral communication competence among students across disciplines. Emphasis on oral communication theory applied to one-on-one support for students oral presentations. May repeat 1 time.
Prerequisite(s): COMM 1016 or COMM 2004
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

CMST 3064 - Persuasion (3 credits)
Theoretical foundations of persuasion; techniques of persuasion; contemporary persuasive practice and campaigns; persuasive media strategies. Junior standing required.
Prerequisite(s): COMM 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3074 - Persuasive Public Speaking (3 credits)
Advanced critical analysis, preparation and presentation of persuasive speeches. Study of advanced rhetorical principles with emphasis on policy speeches and the use of proofs to convince, strengthen beliefs, and motivate listeners to overt action. Advanced focus on approaches to research, audience analysis, effective organization and extemporaneous delivery.
Prerequisite(s): COMM 1016 or COMM 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3124 - Interpersonal Communication (3 credits)
Basic theories and processes of person-to-person communication; interpersonal perception; verbal and nonverbal communication; establishment of relationships in the family and work situation. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3134 - Public Advocacy (3 credits)
Practical reasoning and argumentation about questions of community significance, emphasizing critical thought, rhetorical strategies, and advocacy. Junior standing required.
Prerequisite(s): COMM 2004 or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3164 - Group Processes and Presentations (1 credit)
Study of group theory and its application to a group project, including team dynamics and leadership, conflict resolution, project management, and team presentation strategies.
Instructional Contact Hours: (1 Lec, 1 Crd)

CMST 3214 - Professional Communication (3 credits)
Theory and contemporary practice of professional oral communication, including interpersonal interaction, small group problem-solving, and public presentations. Emphasis on ethical exchanges in traditional or virtual workshops settings.
Prerequisite(s): COMM 1016 or COMM 2004
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3264 - Communication and Gender (3 credits)
Examines how verbal, nonverbal, and visual communication create, sustain, and challenge the meaning of gender and cultural structures and practices. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 3274 - Social Dimensions of Games, Simulations, and Virtual Environments (3 credits)
Social impacts, key issues, and research findings related to video games, simulations, and virtual environments. Ethical, policy, and social dimensions in society; industry data and research. Prerequisite: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4174 - Digital Advocacy Campaigns (3 credits)
Study of advocacy campaigns with digital components. Rhetorical considerations in message construction, analysis of persuasive techniques, ethical standards, and strategies for campaign development. Senior standing required.
Prerequisite(s): (COMM 1016 or COMM 2004) and COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4214 - Web Content Management Strategies (3 credits)
Methodologies, tools, and strategies for managing workflow of communication projects for Web distribution. Software tools for Web-based communication. Quantitative and qualitative methods for usability and readability of Web content. Web analytics and content metrics to support decision making.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4224 - Topics in Media Criticism (3 credits)
Selected topics in media criticism. Offered on demand. Senior standing and consent required.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4244 - Topics in Communication (3 credits)
Selected topics in communication. Application of theory and research in selected context. Ethical and social dimensions of communication issues, policies, and effects. May be repeated with different content for a maximum of 6 credit hours. Pre: Junior standing.
Prerequisite(s): COMM 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

CMST 4284 - Communication for Training and Development (3 credits)
Communication principles and practices for training and development. Communication roles, strategies, and products for learning in workplace environments.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMST 4714 - Senior Seminar in Communication (3 credits)
In-depth study of an issue or theme in communication. Communication theories, issues, policies, effects, and contexts. Research and presentation of research. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

Undergraduate Course Descriptions (COMM)

COMM 1004 - First-Semester Experience in Communication (1 credit)
Introduction to areas of research, ethical behaviors, and career paths in the discipline. Consideration of strategies for learning, accessing advising, and locating resources.
Instructional Contact Hours: (1 Lec, 1 Crd)

COMM 1014 - Introduction to Communication (3 credits)
Survey of the communication discipline across areas of specialization from interpersonal to mediated and mass communication, including history and fundamental concepts, theories, contexts. Emphasis on ethical human behavior and message analysis.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 1015 - Communication Skills (3 credits)
Introduction to oral and written communication. 1015: Focus on oral and written communication in interpersonal, small group, and public contexts. Special emphasis on the writing process, listening, interviewing, conflict resolution, critical analysis, and communication in digital and visual media. 1016: Continued Study in oral and written communication skills for small group and public contexts. Focus on practical applications in ethical research and information gathering, audience analysis and adaptation, message development, and oral, written, and visual presentations by individuals and groups.
Pathway Concept Area(s): 1F Discourse Foundational, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 1016 - Communication Skills (3 credits)
Introduction to oral and written communication. 1015: Focus on oral and written communication in interpersonal, small group, and public contexts. Special emphasis on the writing process, listening, interviewing, conflict resolution, critical analysis, and communication in digital and visual media. 1016: Continued Study in oral and written communication skills for small group and public contexts. Focus on practical applications in ethical research and information gathering, audience analysis and adaptation, message development, and oral, written, and visual presentations by individuals and groups.
Prerequisite(s): COMM 1015
Pathway Concept Area(s): 1F Discourse Foundational, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2004 - Public Speaking (3 credits)
Strategies and practice for speaking to specific audiences. Ethical considerations for message preparation, development, presentation, and evaluation. Pre: Sophomore standing.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2014 - Communication Principles of Teamwork (3 credits)
Behavior of people working in groups. Theories and models of communication, types of groups, principles of effective teamwork. Intrapersonal and interpersonal communication and values related to group behavior, relationships, and problem solving. Ethical issues associated with group work. Pre: Sophomore standing required.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2024 - Media Writing (3 credits)
Writing and information gathering skills including news, features, press releases, and advertising copy for broadcast, print and public relations media. Sophomore Standing Required.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2084 - Media and Society (3 credits)
An examination of media influence on society. Emphasis on impact of media (such as newspapers, film, social networks, and video games) on diverse audiences and cultures. Considerations of the evolution of media; social institutions and trends related to the media; domestic, global, ethical, and legal questions posed by the media; intercultural communication; and new technologys influence on society.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2094 - Communication and Issues of Diversity (3 credits)
Study of communication theory and practice related to diversity and the media. Analysis of ethical implications of media influences on workplace communication across disciplines. Development of a personal understanding of diversity and identity by examining media producers, audiences, workforces, outlets, and content.
Prerequisite(s): COMM 1016 or ENGL 1106
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2124 - Introduction to Communication Research (3 credits)
Study of approaches to research in the discipline, including identification and analysis of existing research; procedures for conducting and reporting basic research in communication. Sophomore Standing required.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 2754H - Topics in Single Medium Communication About Technology Innovation (1 credit)
Study of discovery, analysis, creation, and evaluation of single medium - written or spoken or visual - presentations of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape written, oral, or visual expression in the United States and vice versa. Special attention to single medium communications with stakeholders in business, government agencies, nonprofit organizations, and universities. Ethical dimensions of written, spoken, or visual communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): COMM 1016 or ENGL 1105
Pathway Concept Area(s): 1F Discourse Foundational, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

COMM 2764H - Topics in Multimedia Communication About Technology Innovation (1 credit)
Study of the discovery, analysis, creation, and evaluation of multimedia presentation of ideas related to collaborative technology innovation for societal impact. Analysis of how race, class, gender, and age shape multimedia expression and vice versa. Special attention to communicating across disciplinary, organizational, and cultural differences in the workplace. Ethical dimensions of multimedia communication about collaborative technology innovation for societal impact. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): COMM 2754H
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

COMM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

COMM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4024 - Communication Law (3 credits)
Study freedom of speech and the press and how these freedoms apply to the press, public relations, advertising and personal speech. Consideration of First Amendment theories and jurisprudence; related ethical issues. Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

COMM 4204 - Communication Internship (1-6 credits)
Placement in a communication industry for practical internship under supervision by a departmental advisor and a professional in the field. May be repeated for credit up to a maximum of 6 hours credit. Pre: Junior standing and consent required.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 6 credit hours

COMM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

COMM 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (JMC)

JMC 1114 - Introduction to Media Production Technology (3 credits)
Introduction to basic technologies necessary for multimedia production. Attention to aesthetics and technical aspects of production technologies, including creation, editing, and organization of content. COURSE FEE $95.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 2034 - Visual News Reporting (3 credits)
News reporting through photography, videography, online outlets, and data visualization. Concepts of visual storytelling. Design and production tools and techniques for visual news and feature stories. News elements and journalism ethics in visual communication. Pre: Sophomore standing.
Prerequisite(s): COMM 1016 or ENGL 1106 or ENGL 1204H
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 2074 - Introduction to Sports Media (3 credits)
Development, concepts, and impact of sports media, including roles and responsibilities of journalists, production staff, and public relations professionals. Considerations of stakeholders behaviors and connections. Study of ethical standards and perspectives, communication in sports organizations, types of media, issues in context, and data analytics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3114 - Video Production: Studio (3 credits)
Producing, directing, and writing live video segments; operating control room and studio equipment including studio camera, video switcher, audio board and the creation of video graphics and written packages.
Prerequisite(s): COMM 2034
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

JMC 3154 - Multimedia Reporting (3 credits)
Multimedia news gathering, news writing, audio/visual storytelling, and news judgment for the print and online media. Consideration of professional strategies and standards for reporters, including legal and ethical issues.
Prerequisite(s): COMM 2024 and COMM 2034
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3174 - Advanced Multimedia Reporting (3 credits)
Multimedia gathering and writing of complex news, features, and documentary; visual content and news judgment for television, print and online media; techniques of broadcast interviewing and on-camera performance. Considerations of legal and ethical issues related to the reporting of complex news.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

JMC 3184 - Media Weather Reporting (3 credits)
Techniques for gathering meteorological, information, reporting weather news, and delivering weather forecasts through print, broadcast and online media. Weather information in disaster response. Ethical uses of weather information in reporting threats to public safety.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3244 - Political Communication (3 credits)
Distribution of political information; elite-mass communication; alternative models of political communication; communication and telecommunications policy.
Prerequisite(s): PSCI 1014 or PSCI 1014H or PSCI 1024 or PSCI 1024H or IS 1024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3244

JMC 3254 - Media and Politics (3 credits)
Explores the role of the mass media in contemporary American politics by examining the development of media as sources of social and political influence. Study of news organizations, their coverage of electoral and issue campaigns, and their impact on candidates and voters. Includes the role of new technologies in campaigns. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3254

JMC 3284 - Data Journalism (3 credits)
Numeracy and data analysis in news reporting. Data sourcing and visualization in storytelling. Ethical and legal issues in data use. Careers in data journalism.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3304 - Topics in Sports Communication (3 credits)
Study of the theory and practices related to sports communication in fields such as public relations or reporting. Topics may include print, broadcast, and online news; college sports information; social media; crisis management; and media relations. May be repeated once with different course content. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3314 - Sports Journalism (3 credits)
Theory and practice of sports journalism, including strategies for writing and broadcasting sports information. Study of ethics and professional standards. Junior standing required. Fee $95.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3324 - Sports Play-by-Play Reporting (3 credits)
Audio and video play-by-play sports reporting and commentary for broadcast and online media. Game research and preparation techniques. Voice pacing, inflection, delivery, airtime management, and ad-libbing skills. Command and use of game statistics. Ethical issues in sports play-by-play reporting and commentary. COURSE FEE $67.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3334 - Sports as Entertainment (3 credits)
Evolution of print, broadcast, and online sports coverage into a leading form of entertainment in the United States. Economic, political, and cultural influences of sports and sports betting in U.S. society. Sports portrayals, personalities, and scandals in movies, music, radio, and television through U.S. history. Ethical perspectives on sports as entertainment.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 3344 - Sports Data Journalism (3 credits)
Game statistics and data analysis in sports reporting. Data visualization in sports storytelling. Data sources, sports performance trends, and predictions. Ethical and legal issues in sports data use.
Prerequisite(s): JMC 3314 and COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4014 - Media Effects (3 credits)
Impact of mass media on individuals and on society; methods for documentation of media effects; research about effects on various demographic groups such as children, elderly, and minorities; effects of advertising; effects of interactive and time shift technologies. Junior standing required.
Prerequisite(s): COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4044 - International Communication (3 credits)
Comparative perspectives on global communication systems; problems with the flow of information; roles of international organizations; mass communication and national development; implications for conflict resolution; selected case studies. Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4044

JMC 4064 - Social Media Analytics (3 credits)
Introduction to analytic techniques for social media platforms. Quantitative and qualitative analytic techniques. Design, implementation, and analysis of experimental and observational studies of how people use and engage with social media platforms and how platforms themselves can be used to drive engagement with content. History and trending topics in social media use. Ethical issues involving social media and big data.
Prerequisite(s): COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4094 - Broadcast Management (3 credits)
Broadcast management procedures; programming; sales and advertising. Senior standing required.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4114 - Photojournalism (3 credits)
Interpretive and creative photography applied to journalism; cameras, films, photography techniques; history of photography as communication; advanced darkroom techniques. Junior standing required.
Prerequisite(s): COMM 2034 and COMM 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4134 - Editorial Writing (3 credits)
Development and function of the editorial page; writing of editorials, reviews, and personal columns; examination of role of letters and syndicated columns and cartoons; problems editorial writers face in their jobs and communities. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4144 - Magazine Writing (3 credits)
The writing of feature material (as opposed to the reporting of hard news), plus detailed examination of several article types from a wide variety of contemporary magazines and newspapers. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4254 - Topics Multimedia Journalism (3 credits)
Selected topics in multimedia journalism; emphasis on critical analysis of issues in journalism, and application of media to disseminate information. May be repeated for credit up to a maximum of 6 credit hours with different content.
Prerequisite(s): COMM 2024 and COMM 2034
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

JMC 4264 - Social Media Theory and Practice (3 credits)
Study of social media as a professional communication and media tool. Emphasis on foundations in communication theory and contemporary approaches.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4274 - Broadcasting Performance (3 credits)
Advanced study of on-air performance for broadcasters. Professional behaviors and strategies for developing conversational writing, broadcast style, interviewing, reporting, and anchoring. Fee $95.
Prerequisite(s): COMM 3154 or JMC 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4334 - Communication Ethics (3 credits)
Discussion of issues related to professional communication ethics; emphasis on recognizing ethical issues, applying theoretical models and critical thinking skills to ethical issues in multimedia journalism, public relations, and communication studies. Includes research on topics related to communication ethics. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4344 - Free Speech in Cyberspace (3 credits)
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4344H - Free Speech in Cyberspace (3 credits)
Discussion of free expression on the Internet; an examination of how First Amendment law; state laws and federal communication policies impact the multiple kinds of speech that take place in cyberspace; examination of the history and development of the Internet and the future of free speech in cyberspace. Pre: Senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4374 - New Communications Technology (3 credits)
Identify recent trends in the innovation of new communications technologies; storage, transmission, and display systems of mediated communication: optical disc, common carriers, telecommunication-computer linkages, high-definition TV, and virtual reality; information industries and society; markets for new and existing telecommunication services. Junior standing required.
Prerequisite(s): COMM 2084 or COMM 4014 or JMC 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

JMC 4814 - Digital Newsroom: Online (3 credits)
Production of news content for social networks, mobile applications and web-based content management systems. Preparation of news and feature stories on deadline in a newsroom setting. Collection of information from diverse sources. News judgment. Production requirements for online platforms. Audience engagement. Ethical and legal issues in news reporting. Design/lab studio. COURSE FEE $95.
Prerequisite(s): JMC 3174
Instructional Contact Hours: (5 Lab, 3 Crd)

JMC 4824 - Digital Newsroom: Broadcast (3 credits)
Production of news content for broadcast. Preparation of news and feature stories on deadline in a newsroom setting. Collection of information from diverse sources. News judgment. Videography and digital editing. Broadcast performance. Ethical and legal issues in news reporting. Design lab/studio. $95 COURSE FEE.
Prerequisite(s): JMC 3174
Instructional Contact Hours: (5 Lab, 3 Crd)

JMC 4834 - Sportscenter (3 credits)
Gather, formulate, and deliver sports stories to diverse audiences through print, online, and broadcast channels. Produce sports news on deadline in a newsroom setting. Ethical and legal issues in sports journalism. Design lab/studio. COURSE FEE $95. Pre: Senior standing.
Prerequisite(s): JMC 3314 and JMC 4274 and COMM 2024
Instructional Contact Hours: (5 Lab, 3 Crd)

Undergraduate Course Descriptions (PR)

PR 2044 - Principles of Public Relations (3 credits)
Principles of public relations practice; public relations in organizations; responsibilities of the public relations practitioner; legal and ethical considerations; role of public relations in society; history of the field and key people who influenced its development; choosing appropriate communication channels/media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3014 - Public Relations Cases (3 credits)
Analysis of contemporary and historic public relations cases. Emphasis on theories, research techniques, planning methods, implementation strategies, evaluation standards, and ethical considerations in public relations programs and campaigns.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3034 - Topics in Public Relations and Advertising (3 credits)
Selected topics in public relations and advertising. Emphasis on theoretical, practical, or ethical issues in selected contexts. May be repeated 1 time with different content for a maximum of 6 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: ADV 3034

PR 3084 - Advanced Public Relations Research Methods (3 credits)
Analysis and implementation of contemporary academic and professional research tools for public relations. Emphasis on development of research designs, assessment and evaluation of public relations programs and campaigns, and implementation of ethical research practices and standards.
Prerequisite(s): (COMM 2044 or PR 2044) and COMM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3144 - Writing and Editing for Public Relations (3 credits)
Advanced writing and editing used to structure and present information in public relations practice. Includes message development, message design for delivery through various media, copyediting skills and tools, strategies for dissemination, and legal and ethical issues in public relations writing.
Prerequisite(s): COMM 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3324 - Corporate Communication (3 credits)
Examines communication theories, strategies and tactics that corporations use in their public relations efforts to reach and influence publics. Prepares students for in-house public relations work and familiarizes them with expectations of corporate clients. Introduces students to the important role communication plays within and between for-profit, nonprofit, and government institutions. Emphasis on the influence of corporate culture, ethics and values on communication styles. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3334 - Public Relations and Corporate Social Responsibility (3 credits)
Explores role of communication in corporate social responsibility. Emphasis on the ethical implications of communicating the need to generate profits with the need to ensure that corporate actions do not harm important stakeholders such as employees, investors, customers, and communities.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 3344 - Public Relations and Sports (3 credits)
Examines communication theories, strategies, and tactics that sports organizations use in their public relations efforts. Introduces students to the dynamic relationship between sports organizations, media, and fans. Study of ethics and professional standards in sports public relations. Emphasizes the role of public relations in sports as a strategic communication and management function.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4074 - Organizational Communication (3 credits)
Role of communication in complex organizations; communication networks, communication and management, message systems, decision-making; relationships between organizational theory and communication.
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4164 - Public Relations Administration (3 credits)
Public Relations (PR) administration issues related to budgeting, strategy, legal issues, and campaigns in an organization. Emphasis on PR theory and ethics.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4304 - Public Relations Campaigns (3 credits)
Public relations campaign research, planning, implementation and evaluation. Emphasis on applying theory in campaign contexts; executing applied research; setting objectives; developing strategic plans, messages and budgets; carrying out courses of action; and evaluating results.
Prerequisite(s): COMM 2124 and (COMM 3144 or PR 3144) and (COMM 3014 or PR 3014)
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4364 - Crisis Communication and Issue Management (3 credits)
Communication theories of risk, crisis, emergency, and public/private issue management. Legal and ethical considerations in issue management and crisis communication. Communication strategies and tactics for issue and crisis management. Reputation management and image restoration as they relate to risk, crises, emergencies, and issues.
Prerequisite(s): PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4404 - Strategic Communication Capstone (3 credits)
Research and theory in strategic communication. Cultural awareness of diverse publics. Relationship, reputation, crisis, and issue management in interpersonal, group, organizational, and corporate communication contexts. Ethical standards in strategic communication. Corporate social responsibility.
Prerequisite(s): PR 2044 and AHRM 1014 and ACIS 1004 and (COMM 1016 or COMM 2004)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PR 4414 - Public Relations Standards and Practices (3 credits)
Addresses complexities of public relations research, planning, implementation, and evaluation required for professional certification. Includes special emphasis on public relations legal and ethical practices. Senior standing.Fee $150.
Prerequisite(s): COMM 2044 or PR 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

Advertising Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
COMM 1004	First-Semester Experience in Communication	1
COMM 1014	Introduction to Communication	3
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
COMM 4024	Communication Law	3
Subtotal		19
Major Requirements		
ADV 3004	Advertising Copywriting and Brand Storytelling	3
ADV 3014	Account Planning and Media Buying	3
ADV 3024	Ethics and Social Responsibility in Advertising	3
COMM 2034	Visual Media	3
MKTG 3104	Marketing Management	3
MKTG 3504	Advertising	3
MKTG 4204	Consumer Behavior	3
PR 4304	Public Relations Campaigns	3
or MKTG 4304	Marketing Communications	
Restricted Electives		
Select three restricted electives from the applicable table below.		9
Subtotal		33
Minor and Electives		
Complete 23 credits of minor, cognate, or double major and electives [2]		23
Subtotal		23
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills [1]	3
COMM 1016	Communication Skills [1]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] Students who transfer into the major after their freshman year may substitute ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing for COMM 1015 Communication Skills and COMM 1016 Communication Skills. Those transfer students should take COMM 2004 Public Speaking for Pathways Concept 1A and COMM 2014 Speech Communication for 3 of the required credits hours toward Pathways Concept 3.

[2] In addition to the requirements shown, students must complete the following to reach 120 credits for graduation:

1. **Minor, cognate, or double major**—*Beyond* studies in Advertising and other mass communication disciplines, students must build content knowledge in another area of focus by completing a minor or cognate (minimum 18 credits) or double major (credits vary by major).
2. **Electives**—Once students complete a minor or cognate, they may still need hours for graduation. Students might consider education abroad, an internship, a field study, undergraduate research, independent study, or other non-required Pathways or foreign language courses. Students **should not include ADV, COMM, JMC, or PR courses** among these electives.

Major Restricted Electives

Code	Title	Credits
ADV 2134	Introduction to Health Communication	3
ADV 3034	Topics in Public Relations and Advertising	3
ADV 4324	Issues in Health Communication	3
ART 1234	Topics in Visual Communication Design for Non-Majors	3
ART 3574	Topics In Graphic Design	3
ART 4504	Topics in Multimedia Studio	3
COMM 4204	Communication Internship	1-6
COMM 4994	Undergraduate Research	1-19
JMC 4064	Social Media Analytics	3
JMC 4264	Social Media Theory and Practice	3
MGT 3304	Management Theory and Leadership Practice	3
MKTG 3164	Introduction to Digital Marketing Strategy	3
PR 2044	Principles of Public Relations	3
PR 3014	Public Relations Cases	3
PR 3084	Advanced Public Relations Research Methods	3

PR 3144	Writing and Editing for Public Relations	3
PR 3324	Corporate Communication	3
PR 3334	Public Relations and Corporate Social Responsibility	3

Progress Toward Degree

A student will be certified as making satisfactory progress toward a degree by meeting these requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first 3 classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first 6 classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first 8 classes (24 credits) in the major.
- Overall GPA—Students who fall below 2.0 will follow university policies for probation and subsequent suspension if the GPA is not raised during the probation period.
- Major GPA—Students who fall below 2.0 in their major coursework will have one semester to regain the required GPA standards. All ADV, COMM, JMC and PR courses are included in this calculation. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in ADV or another School of Communication major.

Graduation Requirements

1. Minimum of 120 semester credit hours from the following categories: Degree Core Requirements, Major Requirements, Major Restricted Electives, Pathways to General Education, and Minor and Electives.
2. Minimum of 40 credits in ADV, COMM, JMC or PR; minimum of 72 credits outside ADV, COMM, JMC or PR. **Note: Accreditation standards require Advertising Majors to complete at least 72 hours outside ADV, COMM, JMC or PR.**
3. Overall GPA of 2.0; major GPA 2.0, based on all ADV, COMM, JMC and PR courses the student has completed.
4. Courses taken in major to fulfill graduation requirements must be graded A-F (not pass/fail).
5. ADV, COMM, JMC and PR courses taken for a minor may NOT be counted toward major requirements.

Foreign Language Requirement

Foreign Language—Requirement can be met in one of three ways:

- 2 years of single foreign or classical language or American Sign Language in middle or high school, OR
- Credit by examination for a foreign or classical language or American Sign Language (This option is available only to students who learned a foreign language without the benefit of formal training.), OR
- 6 college-level semester credits in a single foreign or classical language or American Sign Language. These credits are in addition to the 120 required for graduation.

First Year

Fall Semester		**Credits**
COMM 1004	First-Semester Experience in Communication	1
COMM 1015	Communication Skills	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
	Credits	**16**
Spring Semester		
COMM 1014	Introduction to Communication	3
COMM 1016	Communication Skills	3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**

Second Year

Fall Semester		
COMM 2024	Media Writing	3
COMM 2124	Introduction to Communication Research	3
COMM 2084	Media and Society	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
	Credits	**15**
Spring Semester		
COMM 2094	Communication and Issues of Diversity	3
COMM 2034	Visual Media	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**

Third Year

Fall Semester		
MKTG 3104	Marketing Management	3
Restricted Electives		3
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
MKTG 3504	Advertising	3
Restricted Electives		3
Restricted Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**

Fourth Year

Fall Semester		
COMM 4024	Communication Law	3
ADV 3004	Advertising Copywriting and Brand Storytelling	3
ADV 3014	Account Planning and Media Buying	3

MKTG 4204	Consumer Behavior	3
Free Electives		3
	Credits	**15**
Spring Semester		
ADV 3024	Ethics and Social Responsibility in Advertising	3
PR 4304 or MKTG 4304	Public Relations Campaigns or Marketing Communications	3
Free Electives		3
Free Electives		3
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Major Restricted Electives

Code	Title	Credits
ADV 2134	Introduction to Health Communication	3
ADV 3034	Topics in Public Relations and Advertising	3
ADV 4324	Issues in Health Communication	3
ART 1234	Topics in Visual Communication Design for Non-Majors	3
ART 3574	Topics In Graphic Design	3
ART 4504	Topics in Multimedia Studio	3
COMM 4204	Communication Internship	1-6
COMM 4994	Undergraduate Research	1-19
JMC 4064	Social Media Analytics	3
JMC 4264	Social Media Theory and Practice	3
MGT 3304	Management Theory and Leadership Practice	3
MKTG 3164	Introduction to Digital Marketing Strategy	3
PR 2044	Principles of Public Relations	3
PR 3014	Public Relations Cases	3
PR 3084	Advanced Public Relations Research Methods	3
PR 3144	Writing and Editing for Public Relations	3
PR 3324	Corporate Communication	3
PR 3334	Public Relations and Corporate Social Responsibility	3

Communication Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
COMM 1004	First-Semester Experience in Communication	1
COMM 1014	Introduction to Communication	3
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
COMM 4024	Communication Law	3
Subtotal		19
Major Requirements		
CMST 2034	Visual Media	3
CMST 2064 or CMST 3064	The Tradition of Rhetoric and Societal Change Persuasion	3
CMST 3214	Professional Communication	3
CMST 4714 or JMC 4064 or JMC 4264	Senior Seminar in Communication Social Media Analytics Social Media Theory and Practice	3
Major Restricted Electives		
Select 5 courses from the below, including at least one at the 4000-level		
ADV 2134	Introduction to Health Communication	
ADV 4324	Issues in Health Communication	
CMST 3024	Digital Publishing	
CMST 3064	Persuasion	
CMST 3074	Persuasive Public Speaking	
CMST 3124	Interpersonal Communication	
CMST 3134	Public Advocacy	
CMST 4174	Digital Advocacy Campaigns	
CMST 4214	Web Content Management Strategies	
CMST 4224	Topics in Media Criticism	
CMST 4244	Topics in Communication	
COMM 4204	Communication Internship	
JMC 1114	Introduction to Media Production Technology	
JMC 2074	Introduction to Sports Media	
JMC 3254	Media and Politics	
JMC 4014	Media Effects	
JMC 4264	Social Media Theory and Practice	
JMC 4334	Communication Ethics	
JMC 4374	New Communications Technology	
PR 3324	Corporate Communication	
PR 4074	Organizational Communication	
Subtotal		27
Free Electives		
Complete 29 credits of minor, cognate, or double major and electives		29
Subtotal		29
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015 & COMM 1016	Communication Skills and Communication Skills [2]	6
Select one 1A course		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select two Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02) courses		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select two Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) courses		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select two Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) courses		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select two 5F courses		6
Select one 5A courses		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select one 6A course		3
Select one 6D course		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		

Select one Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) course	3
Subtotal	45
Total Credits	**120**

[1] In addition to the requirements shown, students must complete the following to reach 120 credits for graduation:

1. **Minor, cognate, or double major**—*Beyond* studies in Communication and other mass communication disciplines, students must build content knowledge in another area of focus by completing a minor or cognate (minimum 18 credits) or double major (credits vary by major).
2. **Electives**—Once students complete a minor or cognate, they may still need hours for graduation. Students might consider education abroad, an internship, a field study, undergraduate research, independent study, or other non-required Pathways or foreign language courses. Students **should not include ADV, COMM, JMC, or PR courses** among these electives.

[2] Students who transfer into the major after their first year may substitute ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing for COMM 1015 Communication Skills and COMM 1016 Communication Skills. Those transfer students should take COMM 2004 Public Speaking for Pathways Concept 1A and COMM 2014 Speech Communication for 3 of the required credits hours toward Pathways Concept 3.

Progress toward Degree

A student will be certified as making satisfactory progress toward a degree by meeting these requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first 3 classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first 6 classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first 8 classes (24 credits) in the major.
- Overall GPA—Students who fall below 2.0 will follow university policies for probation and subsequent suspension if the GPA is not raised during the probation period.
- Major GPA—Students who fall below 2.0 in their major coursework will have one semester to regain the required GPA standards. All COMM, CMST, JMC, and PR courses are included in this calculation. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in COMM or another School of Communication major.

Graduation Requirements

1. Minimum of 120 credits from the following categories: Core Degree Requirements (19), Major Requirements (12), Major Restricted Electives (15), Pathways to General Education (45), Minor and Electives (29).
2. Minimum of 46 credits in COMM, CMST, JMC, or PR; maximum 48 credits in COMM, CMST, JMC, or PR.
3. Overall GPA of 2.0; major GPA 2.0, based on all COMM, CMST, JMC, and PR courses the student has completed.
4. Courses taken in major to fulfill graduation requirements must be graded A-F (not pass/fail).
5. COMM, CMST, JMC, or PR courses taken for a minor may NOT be counted toward major requirements.

Foreign Language Requirements

- 2 years of single foreign or classical language or American Sign Language in middle or high school, OR
- Credit by examination for a foreign or classical language or American Sign Language (This option is available only to students who learned a foreign language without the benefit of formal training.), OR
- 6 college-level semester credits in a single foreign or classical language or American Sign Language. These credits are in addition to the 120 required for graduation.

First Year		
Fall Semester		**Credits**
COMM 1004	First-Semester Experience in Communication	1
COMM 1015	Communication Skills	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**16**
Spring Semester		
COMM 1014	Introduction to Communication	3
COMM 1016	Communication Skills	3
Pathways Concept 4 - Reasoning in the Natural Sciences		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Second Year		
Fall Semester		
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
Pathways Concept 1 - Discourse		3
Pathways Concept 5 - Quantitative and Computational Thinking		3
	Credits	**15**
Spring Semester		
COMM 2124	Introduction to Communication Research	3
CMST 2034	Visual Media	3
Pathways Concept 2 - Critical Thinking in the Humanities		3
Pathways Concept 3 - Reasoning in the Social Sciences		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		3
	Credits	**15**
Third Year		
Fall Semester		
CMST 2064 or CMST 3064	The Tradition of Rhetoric and Societal Change or Persuasion	3
Restricted Electives		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
CMST 3214	Professional Communication	3
Restricted Electives		3
Restricted Electives		3

Free Electives		3
Free Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
COMM 4024	Communication Law	3
Restricted Electives		3
Free Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
CMST 4714 or JMC 4064 or JMC 4264	Senior Seminar in Communication or Social Media Analytics or Social Media Theory and Practice	3
Restricted Electives		3
Free Electives		3
Free Electives		3
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Major Restricted Electives

Code	Title	Credits
ADV 2134	Introduction to Health Communication	3
ADV 4324	Issues in Health Communication	3
CMST 3024	Digital Publishing	3
CMST 3064	Persuasion	3
CMST 3074	Persuasive Public Speaking	3
CMST 3124	Interpersonal Communication	3
CMST 3134	Public Advocacy	3
CMST 4174	Digital Advocacy Campaigns	3
CMST 4214	Web Content Management Strategies	3
CMST 4224	Topics in Media Criticism	3
CMST 4244	Topics in Communication	3
COMM 4204	Communication Internship	1-6
JMC 1114	Introduction to Media Production Technology	3
JMC 2074	Introduction to Sports Media	3
JMC 3254	Media and Politics	3
JMC 4014	Media Effects	3
JMC 4264	Social Media Theory and Practice	3
JMC 4334	Communication Ethics	3
JMC 4374	New Communications Technology	3
PR 3324	Corporate Communication	3
PR 4074	Organizational Communication	3

Multimedia Journalism Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
COMM 1004	First-Semester Experience in Communication	1
COMM 1014	Introduction to Communication	3
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
COMM 4024	Communication Law	3
Subtotal		19
Major Requirements		
JMC 2034	Visual News Reporting	3
JMC 3154	Multimedia Reporting	3
JMC 3174	Advanced Multimedia Reporting	3
JMC 4334	Communication Ethics	3
JMC 4814	Digital Newsroom: Online	3
or JMC 4824	Digital Newsroom: Broadcast	
Major Restricted Electives		
Application Courses		
Select three of the following:		9
JMC 1114	Introduction to Media Production Technology	
JMC 3114	Video Production: Studio	
JMC 3184	Media Weather Reporting	
JMC 3284	Data Journalism	
JMC 4064	Social Media Analytics	
JMC 4114	Photojournalism	
JMC 4134	Editorial Writing	
JMC 4144	Magazine Writing	
JMC 4254	Topics Multimedia Journalism (application topic)	
JMC 4274	Broadcasting Performance	
COMM 4204	Communication Internship	
Theory Courses		
Select two of the following:		6
JMC 4014	Media Effects	
JMC 4254	Topics Multimedia Journalism (theory topic)	
JMC 4264	Social Media Theory and Practice	
JMC 4344	Free Speech in Cyberspace	
JMC 4374	New Communications Technology	
Subtotal		30
Free Electives		
Complete 26 credits of minor, cognate, or double major and electives [1]		26
Subtotal		26
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills [2]	3
COMM 1016	Communication Skills [2]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		

Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)	6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

[1] In addition to degree core, major, and Pathways requirements, students must complete at least 26 credit hours in the following categories to reach 120 credit hours for graduation:

1. **Minor, cognate, or double major**—Beyond studies in Multimedia Journalism and other mass communication disciplines, students must build content knowledge in another area of focus by completing a minor or cognate (minimum 18 credits) or double major (credits vary by major).
2. **Electives**—Once students complete a minor or cognate, they may still need additional credit hours for graduation. Students might consider education abroad, an internship, a field study, undergraduate research, independent study, or other non-required Pathways or foreign language courses. Students **should not include ADV, COMM, JMC, or PR courses** among these electives.

[2] Students who transfer into the major after their freshman year may substitute ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing for COMM 1015 Communication Skills and COMM 1016 Communication Skills. Those transfer students should take COMM 2004 Public Speaking for Pathways Concept 1A and COMM 2014 Speech Communication for 3 of the required credits hours toward Pathways Concept 3.

Progress Toward Degree

A student will be certified as making satisfactory progress toward a degree by meeting these requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first 3 classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first 6 classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first 8 classes (24 credits) in the major.
- Overall GPA—Students who fall below 2.0 will follow university policies for probation and subsequent suspension if the GPA is not raised during the probation period.
- Major GPA—Students who fall below 2.0 in their major coursework will have one semester to regain the required GPA standards. All ADV, COMM, JMC, and PR courses are included in this calculation. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in MJ or another School of Communication major.

Graduation Requirements

1. Minimum of 120 semester credit hours from the following categories: Core Degree Requirements, Major Requirements, Major Restricted Electives, Pathways to General Education, Minor and Electives.
2. Minimum of 46 credits in ADV, COMM, JMC, or PR; minimum 70 credits outside ADV, COMM, JMC, or PR.
3. Overall GPA of 2.0; major GPA 2.0, based on all ADV, COMM, JMC, and PR courses the student has completed.
4. Courses taken in major to fulfill graduation requirements must be graded A-F (not pass/fail).
5. ADV, COMM, JMC, and PR courses taken for a minor may **not** be counted toward major requirements.

Foreign Language Requirement

- 2 years of single foreign or classical language or American Sign Language in middle or high school, OR
- Credit by examination for a foreign or classical language or American Sign Language (This option is available only to students who learned a foreign language without the benefit of formal training.), OR
- 6 college-level semester credits in a single foreign or classical language or American Sign Language. These credits are in addition to the 120 required for graduation.

Roadmap

First Year

Fall Semester		**Credits**
COMM 1004	First-Semester Experience in Communication	1
COMM 1015	Communication Skills	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
	Credits	**16**
Spring Semester		
COMM 1014	Introduction to Communication	3
COMM 1016	Communication Skills	3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**

Second Year

Fall Semester		
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
	Credits	**15**

Spring Semester		
COMM 2124	Introduction to Communication Research	3
JMC 2034	Visual News Reporting	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Third Year		
Fall Semester		
JMC 3154	Multimedia Reporting	3
Restricted Electives		3
Restricted Electives		3
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Free Electives		3
	Credits	**15**
Spring Semester		
JMC 3174	Advanced Multimedia Reporting	3
JMC 4334	Communication Ethics	3
Restricted Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
COMM 4024	Communication Law	3
Restricted Electives		3
Free Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
JMC 4814 or JMC 4824	Digital Newsroom: Online or Digital Newsroom: Broadcast	3
Free Electives		3
Free Electives		3
Free Electives		3
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Major Restricted Electives

Application Courses

Code	Title	Credits
JMC 1114	Introduction to Media Production Technology	3
JMC 3114	Video Production: Studio	3
JMC 3184	Media Weather Reporting	3
JMC 3284	Data Journalism	3
JMC 4064	Social Media Analytics	3
JMC 4114	Photojournalism	3
JMC 4134	Editorial Writing	3
JMC 4144	Magazine Writing	3
JMC 4254	Topics Multimedia Journalism (application topic)	3
JMC 4274	Broadcasting Performance	3
COMM 4204	Communication Internship	1-6

Theory Courses

Code	Title	Credits
JMC 4014	Media Effects	3
JMC 4254	Topics Multimedia Journalism (theory topic)	3
JMC 4264	Social Media Theory and Practice	3
JMC 4344	Free Speech in Cyberspace	3
JMC 4374	New Communications Technology	3

Public Relations Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
COMM 1004	First-Semester Experience in Communication	1
COMM 1014	Introduction to Communication	3
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
COMM 4024	Communication Law	3
Subtotal		19
Major Requirements		
PR 2044	Principles of Public Relations	3
ADV 2034	Visual Communication Strategies	3
PR 3014	Public Relations Cases	3
PR 3144	Writing and Editing for Public Relations	3
PR 4304	Public Relations Campaigns	3
PR 4414	Public Relations Standards and Practices	3
Major Restricted Electives		
Select three of the following:		9
JMC 4044	International Communication	
JMC 4064	Social Media Analytics	
JMC 4264	Social Media Theory and Practice	
PR 3034	Topics in Public Relations and Advertising	
PR 3084	Advanced Public Relations Research Methods	
PR 3324	Corporate Communication	
PR 3334	Public Relations and Corporate Social Responsibility	
PR 3344	Public Relations and Sports	
PR 4074	Organizational Communication	
PR 4164	Public Relations Administration	
PR 4364	Crisis Communication and Issue Management	
COMM 4204	Communication Internship	
COMM 4994	Undergraduate Research	
Subtotal		27
Minor and Electives		
Complete 29 credits of minor, cognate, or double major and electives [1]		29
Subtotal		29
Pathways to General Education		
Pathways Concept 1 - Discourse		

COMM 1015 & COMM 1016	Communication Skills and Communication Skills [2]	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] In addition to degree core, major, and Pathways requirements, students must complete at least 29 credit hours in the following categories to reach 120 credit hours for graduation:

1. **Minor, cognate, or double major**—Beyond studies in Advertising and other mass communication disciplines, students must build content knowledge in another area of focus by completing a minor or cognate (minimum 18 credits) or double major (credits vary by major).
2. **Electives**—Once students complete a minor or cognate, they may still need hours for graduation. Students might consider education abroad, an internship, a field study, undergraduate research, independent study, or other non-required Pathways or foreign language courses. Students should not **include ADV, COMM, JMC, or PR courses** among these electives.

[2] Students who transfer into the major after their freshman year may substitute ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing for COMM 1015 Communication Skills and COMM 1016 Communication Skills. Those transfer students should take COMM 2004 Public Speaking for Pathways Concept 1A and COMM 2014 Speech Communication for 3 of the required credits hours toward Pathways Concept 3.

Progress Toward Degree

A student will be certified as making satisfactory progress toward a degree by meeting these requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first three classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first six classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first eight classes (24 credits) in the major.
- Overall GPA—Students who fall below 2.0 will follow university policies for probation and subsequent suspension if the GPA is not raised during the probation period.
- Major GPA—Students who fall below 2.0 in their major coursework will have one semester to regain the required GPA standards. All ADV, COMM, JMC, and PR courses are included in this calculation. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in PR or another School of Communication major.

Graduation Requirements

1. Minimum of 120 semester credit hours from the following categories: degree core requirements, major requirements, major restricted electives, Pathways General Education, minor, and electives.
2. Minimum of 46 credits in ADV, COMM, JMC, or PR; minimum of 70 credits outside ADV, COMM, JMC, or PR.
3. Overall GPA of 2.0; major GPA 2.0, based on all ADV, COMM, JMC, or PR courses the student has completed.
4. Courses taken in major to fulfill graduation requirements must be graded A-F (not pass/fail).
5. ADV, COMM, JMC, or PR courses taken for a minor may NOT be counted toward major requirements.

Foreign Language Requirement

- 2 years of single foreign or classical language or American Sign Language in middle or high school, OR
- Credit by examination for a foreign or classical language or American Sign Language (This option is available only to students who learned a foreign language without the benefit of formal training.), OR
- 6 college-level semester credits in a single foreign or classical language or American Sign Language. These credits are in addition to the 120 required for graduation.

First Year

Fall Semester		**Credits**
COMM 1004	First-Semester Experience in Communication	1
COMM 1015	Communication Skills	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
	Credits	**16**
Spring Semester		
COMM 1014	Introduction to Communication	3
COMM 1016	Communication Skills	3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3

Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**
Second Year		
Fall Semester		
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
PR 2044	Principles of Public Relations	3
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
	Credits	**15**
Spring Semester		
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
ADV 2034	Visual Communication Strategies	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
	Credits	**15**
Third Year		
Fall Semester		
PR 3014	Public Relations Cases	3
Restricted Electives		3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Free Electives		3
	Credits	**15**
Spring Semester		
PR 3144	Writing and Editing for Public Relations	3
Restricted Electives		3
Free Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
COMM 4024	Communication Law	3
PR 4304	Public Relations Campaigns	3
Restricted Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
PR 4414	Public Relations Standards and Practices	3
Free Electives		3
Free Electives		3
Free Electives		3
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Major Restricted Electives

Code	Title	Credits
JMC 4044	International Communication	3
JMC 4064	Social Media Analytics	3
JMC 4264	Social Media Theory and Practice	3
PR 3034	Topics in Public Relations and Advertising	3
PR 3084	Advanced Public Relations Research Methods	3
PR 3324	Corporate Communication	3
PR 3334	Public Relations and Corporate Social Responsibility	3
PR 3344	Public Relations and Sports	3
PR 4074	Organizational Communication	3
PR 4164	Public Relations Administration	3
PR 4364	Crisis Communication and Issue Management	3
COMM 4204	Communication Internship	1-6
COMM 4994	Undergraduate Research	1-19

Sports Media and Analytics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
COMM 1004	First-Semester Experience in Communication	1
COMM 1014	Introduction to Communication	3
COMM 2024	Media Writing	3
COMM 2084	Media and Society	3
COMM 2094	Communication and Issues of Diversity	3
COMM 2124	Introduction to Communication Research	3
COMM 4024	Communication Law	3
Subtotal		19
Major Requirements		
JMC 2034	Visual News Reporting	3
JMC 2074	Introduction to Sports Media	3
JMC 3154	Multimedia Reporting	3
JMC 3314	Sports Journalism	3
JMC 3174	Advanced Multimedia Reporting	3
JMC 3344	Sports Data Journalism	3
JMC 4334	Communication Ethics	3
JMC 4834	Sportscenter	3
Major Restricted Electives		
Select one of the following:		3
JMC 1114	Introduction to Media Production Technology	
JMC 3114	Video Production: Studio	
JMC 3284	Data Journalism	
JMC 3304	Topics in Sports Communication	
JMC 3324	Sports Play-by-Play Reporting	
JMC 3334	Sports as Entertainment	
PR 3344	Public Relations and Sports	
JMC 4064	Social Media Analytics	
JMC 4094	Broadcast Management	
JMC 4114	Photojournalism	
JMC 4144	Magazine Writing	
JMC 4264	Social Media Theory and Practice	
JMC 4274	Broadcasting Performance	
JMC 4334	Communication Ethics	
JMC 4344	Free Speech in Cyberspace	

JMC 4814	Digital Newsroom: Online	
JMC 4824	Digital Newsroom: Broadcast	
COMM 4204	Communication Internship	
Subtotal		27
Minor and Electives		
Complete 29 credits in minor, cognate, or double major and electives [1]		29
Subtotal		29
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills [2]	3
COMM 1016	Communication Skills [2]	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

[1] In addition to degree core, major, and Pathways requirements, students must complete at least 29 credit hours in the following categories to reach 120 credit hours for graduation:

1. **Minor, cognate, or double major**—Beyond studies in Sports Media and Analytics and other mass communication disciplines, students must build content knowledge in another area of focus by completing a minor or cognate (minimum 18 credits) or double major (credits vary by major).
2. Electives—Once students complete a minor or cognate, they may still need hours for graduation. Students might consider education abroad, an internship, a field study, undergraduate research, independent study, or other non-required Pathways or foreign language courses. Students should not **include ADV, COMM, JMC, or PR courses** among these electives.

[2] Students who transfer into the major after their freshman year may substitute ENGL 1105 First-Year Writing and ENGL 1106 First-Year Writing for COMM 1015 Communication Skills and COMM 1016 Communication Skills. Those transfer students should take COMM 2004 Public Speaking for Pathways Concept 1A and COMM 2014 Speech Communication for 3 of the required credits hours toward Pathways Concept 3.

Progress Toward Degree

A student will be certified as making satisfactory progress toward a degree by meeting these requirements:

- Completion of COMM 1004 First-Semester Experience in Communication within the first 3 classes (9 credits) in the major.
- Completion of COMM 1014 Introduction to Communication within the first 6 classes (18 credits) in the major. Minimum grade of C- required.
- Completion of COMM 2124 Introduction to Communication Research within the first 8 classes (24 credits) in the major.
- Overall GPA—Students who fall below 2.0 will follow university policies for probation and subsequent suspension if the GPA is not raised during the probation period.
- Major GPA—Students who fall below 2.0 in their major coursework will have one semester to regain the required GPA standards. All ADV, COMM, JMC, and PR courses are included in this calculation. A student who fails to make satisfactory progress toward degree after that semester will be blocked from continuing in SMA or another School of Communication major.

Graduation Requirements

1. Minimum of 120 semester credit hours from the following categories: Core Degree Requirements, Major Requirements, Major Restricted Electives, Pathways to General Education, Minor and Electives.
2. Minimum of 46 credits in ADV, COMM, JMC, or PR; minimum 70 credits outside ADV, COMM, JMC, or PR.
3. Overall GPA of 2.0; major GPA 2.0, based on all ADV, COMM, JMC, and PR courses the student has completed.
4. Courses taken in major to fulfill graduation requirements must be graded A-F (not pass/fail).
5. ADV, COMM, JMC, and PR courses taken for a minor may **not** be counted toward major requirements.

Foreign Language Requirement

Foreign Language-Requirement can be met in one of three ways:

- 2 years of single foreign or classical language or American Sign Language in middle or high school, ***OR***
- Credit by examination for a foreign or classical language or American Sign Language (This option is available only to students who learned a foreign language without the benefit of formal training.), ***OR***
- 6 college-level semester credits in a single foreign or classical language or American Sign Language. These credits are in addition to the 120 required for graduation.

Roadmap

First Year

Fall Semester		**Credits**
COMM 1004	First-Semester Experience in Communication	1
COMM 1015	Communication Skills	3

Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
	Credits	**16**
Spring Semester		
COMM 1014	Introduction to Communication	3
COMM 1016	Communication Skills	3
Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		3
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
	Credits	**15**
Second Year		
Fall Semester		
COMM 2024	Media Writing	3
COMM 2124	Introduction to Communication Research	3
COMM 2084	Media and Society	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
	Credits	**15**
Spring Semester		
COMM 2094	Communication and Issues of Diversity	3
COMM 2034	Visual Media	3
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
	Credits	**15**
Third Year		
Fall Semester		
JMC 2074	Introduction to Sports Media	3
JMC 3154	Multimedia Reporting	3
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
JMC 3314	Sports Journalism	3
JMC 4334	Communication Ethics	3
Restricted Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Fourth Year		
Fall Semester		
JMC 3174	Advanced Multimedia Reporting	3
JMC 3344	Sports Data Journalism	3
Free Electives		3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
JMC 4834	Sportscenter	3
COMM 4024	Communication Law	3
Free Electives		3
Free Electives		3
Free Electives		2
	Credits	**14**
	Total Credits	**120**

Major Restricted Electives

Code	Title	Credits
JMC 1114	Introduction to Media Production Technology	3
JMC 3114	Video Production: Studio	3
JMC 3284	Data Journalism	3
JMC 3304	Topics in Sports Communication	3
JMC 3324	Sports Play-by-Play Reporting	3
JMC 3334	Sports as Entertainment	3
JMC 4064	Social Media Analytics	3
JMC 4094	Broadcast Management	3
JMC 4114	Photojournalism	3
JMC 4144	Magazine Writing	3
JMC 4264	Social Media Theory and Practice	3
JMC 4274	Broadcasting Performance	3
JMC 4334	Communication Ethics	3
JMC 4344	Free Speech in Cyberspace	3
JMC 4814	Digital Newsroom: Online	3
JMC 4824	Digital Newsroom: Broadcast	3
PR 3344	Public Relations and Sports	3
COMM 4204	Communication Internship	1-6

School of Education

Our Website (http://www.soe.vt.edu)

Overview

The School of Education offers professional education degrees at both the undergraduate and graduate level. Initial undergraduate licensure programs include Elementary Education, Career and Technical Education (Agriculture, Business and Information Technology, Marketing Education, Family and Consumer Sciences, and Technology Education), Math Education, English Language Arts Education, and History and Social Sciences Education. Graduate initial licensure programs include Elementary Education, Math Education, Science Education (Biology, Earth Science, Physics, and Chemistry), History and Social Science Education, CTE (Agriculture, Business and Information Technology, Marketing Education, Family and Consumer Sciences, and Technology Education) and Music Education (instrumental and vocal). The School of Education also offers advanced licensure programs in Counselor Education, Educational Leadership and Policy Studies, and Reading Specialist preparation. These programs prepare education professionals for varied employment settings. Advanced programs are offered at the master's, education specialist, and doctoral levels. To obtain specific information about these programs and their requirements, interested students should visit the School of Education's website (www.soe.vt.edu)

Entrance to the School of Education

The Council for Accreditation of Educator Preparation (CAEP) requires that all students be formally admitted into professional education programs. This formal program admission is different from admission to Virginia Tech. Virginia Tech undergraduate students pursuing licensure will encounter three key gateways during their academic journey. The three gateways include program admission and candidacy, application to student teaching, and recommendation for Virginia teaching licensure. Each gateway is specially designed to ensure all candidates are well-prepared, highly qualified, and ready to enter the teaching profession upon program completion. The School of Education and undergraduate student advisors will provide guidance documents to students to assist them in navigating the applications to each program gateway.

Licensure and Employment Opportunities

All initial teacher education programs are fully accredited by the Council for the Accreditation of Educator Preparation (CAEP) and the Virginia Department of Education. Graduates of professional preparation programs are well prepared for their initial responsibilities and are actively recruited by school systems across the state. Advisors counsel students early in their programs with respect to post-graduation placement opportunities.

Professional Preparation Programs Offered in the School of Education

The School of Education offers undergraduate teacher education programs in CTE (Agriculture Education, Business and Information Technology Education, Technology Education, Family and Consumer Sciences Education, Marketing Education), Elementary Education (Pk-6), English Language Arts Education, History and Social Sciences Education and Mathematics Education. The School of Education also offers graduate professional preparation programs. Please consult the Graduate Catalog (www.graduateschool.vt.edu (http://www.graduateschool.vt.edu)) and the School of Education's website (www.soe.vt.edu (http://www.soe.vt.edu)) for admission and graduation requirements.

- Career and Technical Education - Agricultural Education Major (p. 1135)
- Career and Technical Education Major with Business and Information Technologies Education Option (p. 1136)
- Career and Technical Education Major with Family and Consumer Sciences Education Option (p. 1137)
- Career and Technical Education Major with Marketing Education Option (p. 1138)
- Elementary Education (PK-6) Major (p. 1139)
- English Language Arts Education Major (p. 1140)
- History and Social Sciences Education Major (p. 1141)
- Mathematics Education Major (p. 1142)
- Technology Education Major (https://catalog.vt.edu/undergraduate/liberal-arts-human-sciences/education/technology-education/)

Professors: M. D. Alexander, A. P. Azano, B. S. Billingsley, B. R. Brand, P. E. Doolittle, D. Hicks, M. L. Johnson, B. D. Jones, G. F. Lawson, H. A. Mesmer, Y. Miyazaki, C. A. Mullen, M. Weaver-Hightower, L. E. Welfare, J. G. Wells, J. L. Wilkins, and T.O. Williams
Associate Professors: H. B. Bayne, B. D. Bowen, C. Catalano, M.C. Fullen, S. F. Hein, T. B. Lane, C. L. Lowery, D.A. Robertson, and T. T. Stewart
Assistant Professors: A. E. Allen, N.K. Ferand, S. M. Henry, B. D. Hunt, H. M. Locklear and L. Taylor and C. Thomas
Collegiate Professors: G. A. Holmes and J.S. Mukuni
Professors of Practice: S. D. Adams, N. A. Bradley, J. L. Brinkmann, C.S. Cash, J. Collins, D. J. Fortune, C.S. Foster, D.J. Kniola and B. Kreye
Visiting Professor: R. Kuehl
Administrative and Professional Faculty: C. J. Christianson

Undergraduate Course Descriptions (EDCI)

EDCI 1004 - Introduction to Teacher Education and Licensure (1 credit)
Introduction to the School of Education and teacher education program including majors that lead to teacher licensure, education career exploration, curriculum requirements of licensure programs, and state licensure regulations. Review of academic skills, university programs, and services that support students and promote student development.
Instructional Contact Hours: (1 Lec, 1 Crd)

EDCI 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 2004 - Exploring the Teaching Profession- Field Studies in Education (3 credits)
Experiential learning,10 hours per week, in a classroom setting, public or private, exposing students to knowledge, skills, and dispositions of professional educators. Allows for integration of experiential and course-based learning in professional identity formation and classroom management. Introduces students to concepts and terminology necessary for upperlevel educator preparation courses.
Prerequisite(s): EDCI 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2414 - Design Based Biotechnical Learning (3 credits)
STEM disciplinary content and practice. Design, construction, evaluate, and iterate working biotechnical prototype solutions addressing authentic human needs. Ethical decision-making based on technological solutions appropriate for local and/or global communities.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2464 - Foundations of Social Studies Education (3 credits)
Introduction to social studies and the study of the social world in all its complexity including the interactions between people, cultures, societies, systems, and ways of being in the world. Exploration of what social studies encompasses, including its purposes and foundational concepts to provide a content-based foundation for future social studies teachers in history, geography, civics, and economics.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2574 - Social Foundations of Education (3 credits)
History, purpose, and social contexts of education and the PK 12 public education system in the US. Diversity and culturally sensitive approaches to education. Historical, philosophical, social, cultural, and political factors that influence teachers roles and responsibilities and educational practice.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2614 - The Reading Mind: Learning to read (3 credits)
Survey of theories and research that explain how people learn to read. Brief overview of English written systems. Models of skilled reading, literacy stages, and component processes (e.g., decoding, comprehension). Application of course concepts to self, common myths, media, and products. Analysis of patterns of inequity in reading achievement.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2674 - Language, Culture, and Learning (3 credits)
This course explores connections between language, culture, and learning. Emphasis on recognizing and critically examining ways that diversity of cultural contexts and social identities influence learning, and challenging students to consider ethical responsibilities in supporting and participating in an equitable society.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 2984 - Special Study (1-19 credits)
Repeatable with different course content.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

EDCI 3004 - Pre-Education Seminar (1-6 credits)
Experiential learning in a PreK through 12th grade setting, public or private, exposing students to knowledge, skills, and dispositions of professional educators. Allows for integration of experiential and course-based learning in professional identity formation and exploration of education careers. NOT student teaching. May be repeated for elective credit up to a maximum of 12 credit hours. Pre: Junior standing.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 12 credit hours

EDCI 3024 - Issues of Schooling in the United States (3 credits)
Exploration of U.S. education, purposes, and roles. Impacts of historic, social, political, economic, religious, cultural, global, and curricular issues. Analysis of equal educational opportunity. Role of the teaching profession in educational reforms.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3074 - Elementary Curriculum: Methods in Teaching (3 credits)
Instructional approaches in elementary education curriculum with a focus on: family engagement, collaboration, teaching strategies, behavior and classroom management, assessment, and differentiation. Design and implementation of lesson plans for elementary school students. Professional educator standards.
Corequisite(s): EDCI 3964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3144 - Education of Exceptional Learners (3 credits)
Introduction to the historical, ethical, legal, and economic models relevant to understanding students with disabilities and meeting their needs to increase their potential for success throughout their lives. Addresses research in early intervention, K-12 instruction, post-secondary education, and transition into work settings.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 3144

EDCI 3234 - Foundations of Reading Instruction (PK-6) (3 credits)
Theoretical, practical, and research-based foundations in the science of reading instruction for grades PK-6. Phonics, phonological awareness, fluency, vocabulary, and comprehension instruction. Assessment-informed instruction, classroom organization, reader-text matching.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3244 - Curriculum and Instruction in Elementary Mathematics, PK-3 (3 credits)
Key concepts in curriculum and instruction in grades PK-3 mathematics: mathematical thinking, number and number sense, computation and estimation, geometry and measurement, mathematical discourse within elementary classrooms, teaching methods in grades PK-3, and the role of mental arithmetic. Teaching mathematics through problem solving, reasoning, and communication to support the learning process for all elementary students.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3254 - Elementary Methods in Science (3 credits)
Study and analysis of approaches to elementary science instruction; assessment for learning; instructional design and methods; content integration in lesson plans; inquiry based science investigations; planning science investigations; needs of students; and inclusiveness of learners.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3334 - Teaching Language Arts in the Elementary Classroom (4 credits)
Implementation and assessment of curriculum and instruction in elementary language arts. The six focus areas of writing, speaking, listening, reading, visual representation, and viewing are the core components and the role of childrens literature in language learning.
Instructional Contact Hours: (4 Lec, 4 Crd)

EDCI 3354 - STEM in Elementary Schools (3 credits)
STEM education for pre-service elementary education teachers. Equity in elementary science education. Inquiry as a process in society. Integration of inquiry-based practices and engineering design. STEM activities that mirror real-world problem solving and innovation. Next Generation Science and VDOE standards and engineering models, including 5E Instructional Model, in instructional design.
Prerequisite(s): EDCI 3254
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3464 - Elementary Social Studies Teaching Methods (3 credits)
Emphasizes foundational concepts of curriculum in Social Studies for preservice teachers to effectively utilize state and federal standards to guide instructional strategies and assessments in the elementary classroom (PK-6). Functions of Virginia state and local governments. Exploration of alternative approaches with instructional strategies.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3474 - Assessment and Diagnosis in Elementary Mathematics Classroom (3 credits)
Research in assessment and diagnosis in PK-5 mathematics classroom. Comparison of evaluation and assessment methods and development of assessment models appropriate for use in PK-5 mathematics classrooms. This course involves the exploration of formative and summative assessment tools, formal and informal assessment strategies, and critical issues in assessment practices.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 3954G - Study Abroad (1-19 credits)
Pathway Concept Area(s): 7 Identity & Equity in U.S.
Instructional Contact Hours: Variable credit course

EDCI 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4014 - History Lab: Creative Technologies, Hidden Histories, Informal Learning (3 credits)
Application of creative technologies to visualize hidden histories in transdisciplinary experiential learning projects. Training in creative technologies, informal learning techniques, interpretation of marginalized histories, and digital cultural heritage design. Consideration of ethical questions involving the representation of diverse social identities, traditions, and histories. Pre: Sophomore Standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ART 4014, HIST 4014

EDCI 4024 - Humanizing the K-12 Classroom (3 credits)
Social, political, economic and historic structures maintaining power and privilege in the K-12 education system that disadvantage students of different racial, ethic, socioeconomic, class, and cultural groups. Classroom environmental design to support equity and social justice. Impact of teacher and student identity development on student learning. Twenty hours of experiential learning in educational setting. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4074 - Culturally Responsive Teaching in the Elementary Classroom (3 credits)
In-depth, extensive, and reflective understandings of diversity regarding individual students, families, communities, and schooling contexts. Classroom instructional and management strategies that are responsive to cultural and linguistic differences.
Corequisite(s): EDCI 4964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4244 - Curriculum and Instruction in Middle School Mathematics (4-8) (3 credits)
Key concepts in curriculum and instruction in grades 4-8 mathematics to meet diverse learning needs. Algebraic structure of the rational numbers as it relates to childrens understanding of fractions, decimals, and percents, algebraic and proportional reasoning, and probability and data analysis. Childrens mathematical thinking and learning from a psychological perspective. Teaching mathematics through problem solving, reasoning, and communication to promote an inclusive community of learning based on appropriate educational theories.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4264 - Intro to Reading Instruction for Elementary Students: A Clinical Course (3 credits)
Overview of reading theory, terminology, and development in grade K-5. Introduction to reading assessment, text selection, lesson planning, and instructional strategies. Supervised clinical setting instructing K-5 learner. Pre: Junior or senior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4274 - Curriculum and Instruction in Middle School Mathematics (3 credits)
Key concepts in curriculum and instruction in middle school mathematics to meet diverse learning needs. Algebraic structure of the rational numbers as it relates to understanding of fractions, decimals, and percents, algebraic and proportional reasoning, and probability and data analysis. Mathematical thinking and learning from a psychological perspective. Teaching mathematics through problem solving, reasoning, and communication to promote an inclusive community of learning based on appropriate educational theories.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4454 - Engr. Leadership/Mgmt (3 credits)
Introduction to management and mentoring skills associated with the application of the engineering design process. Course covers skills necessary for leading diverse teams of people through a technical design project. Managing teams of local high school students through an authentic technical design experience associated with design competitions. Course addresses the practical applications of science, math and engineering, while building and managing teams of people to meet technical project goals. Prerequisite: ME 4015 or similar team-based design experience, or by permission of instructor.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ME 4454

EDCI 4554 - Educating Exceptional Learners (3 credits)
Analysis of purpose, rationale, and foci of educational programs, and related services for individuals with special needs. Identification of characteristics associated with each exceptionality covered by the Individuals with Disabilities Education Act. Review of procedures for assessment, eligibility decisions, and the development of individualized educational programs. Overview of selected instructional strategies, environmental adaptations, and special materials. Examination of findings concerning program efficacy. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4724 - Secondary School Teaching Methods I (3 credits)
Methods for designing and implementing instruction in specific middle and high school content area classrooms (CTE, English, history, social sciences, mathematics, and music) in conjunction with a field experience course. Lesson planning, assessment, differentiation, technology, standards, and adolescent learning development. Reflectivity and collaboration for continuous improvement.
Corequisite(s): 3964, or EDCT 3964, or EDTE 6964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4734 - Adolescent Literacy and Reading (3 credits)
Challenges to adolescent literacy. Basic processes related to reading, comprehension, vocabulary development, and conceptual knowledge; diverse adolescent readers. Effective plans and teaching strategies for comprehending and using information in disciplinary texts in middle and high school content area classrooms. (Career and Technical, English, history, math, music, and science).
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4744 - Secondary School Teaching Methods II (3 credits)
Methods for designing and implementing a variety of instructional approaches in specific middle and high school content area classrooms (CTE, English, history, social sciences, mathematics, and music) in conjunction with student teaching internship. Emphasis on planning and implementation of instructional design, research inquiry, classroom management, integration of technology. Unit plan development and evaluation.
Prerequisite(s): EDCI 4724
Corequisite(s): 3964 or EDTE 3964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCI 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCI 4984 - Special Study (1-19 credits)
Repeatable with different content.
Instructional Contact Hours: Variable credit course
Repeatability: up to 99 credit hours

EDCI 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (EDCO)

EDCO 2004 - Healthy Relationships: Understanding Self and Others (3 credits)
Basic concepts, skills, and theory associated with creating and sustaining healthy relationships in social and professional settings. Self-awareness as it relates to relationship-building. Characteristics and identities of self and others as they relate to relationship-building. Relationship-building skills such as active listening, perspective taking, and empathy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (EDCT)

EDCT 1474 - Computer Information Systems (3 credits)
Fundamentals of Information Technology. Social and individual impact of technology. Software and hardware technologies. Networking, programming, and development.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 2604 - Introduction to Career and Technical Education (3 credits)
Philosophies, history, legislation, context, administration and delivery systems of the various licensure areas included in Career and Technical Education.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4004 - International Trends in Workforce Development (3 credits)
Trends in international workforce development including global talent supply and demand; portable skills and workforce readiness; social, economic and employment issues; worker values; impact of technology, and workplace communication skills for effective writing, speaking, reading, and listening.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4034 - Methods of Planning Educational Programs in Agriculture (3 credits)
Course examines the procedures involved in the development of courses, curriculum, and instructional materials for education programs in agriculture.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALCE 4034

EDCT 4624 - Managing a Career and Technical Education Program (3 credits)
Responsibilities of a Career and Technical Education teacher. Managing CTE program based on operational polices, promoting program to in-school and external stakeholders, implementing work-based learning, advising program student organizations, and creating a community-based program.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4634 - Student Assessment in Career and Technical Education (3 credits)
Assessment of standards-based outcomes of learning in workforce development and career and technical education programs. Focus on work-based learning, hands-on competencies, Cognitive Learning Targets, and performance assessment. Pre: Senior standing.
Prerequisite(s): EDCT 2604 and EDCT 2964
Instructional Contact Hours: (3 Lec, 3 Crd)

EDCT 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Pre: Recommendation of program area and successful completion of Professional Studies requirement.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)
Repeatability: up to 16 credit hours

EDCT 4884 - Youth Program Management (3 credits)
Organizational design of educational youth programs such as 4-H and FFA, including administrative planning, human resource development, recruitment, marketing, and budgeting.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALCE 4884

EDCT 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDCT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (EDEP)

EDEP 2374 - Educational Psychology for PK-12 Teachers (3 credits)
Theoretical, empirical, and practical foundations of educational psychology, including human learning, cognitive processes, development, motivation, classroom management, and instructional strategies for diverse students. Emphasis on application of theory to practice.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 2444 - Motivating Yourself and Others (3 credits)
Survey of human motivation research and research methodologies in education, psychology, and neuroscience. Application of this research in diverse populations, including analysis of human motivation and design of motivating activities. (3H,3C)
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDEP 3474 - Principles and Practices in PK-12 Assessment (3 credits)
Theoretical, empirical, and practical foundations of assessment in PK-12. Basic test design and measurement principles and practices, the use of assessments in education, the use of assessment data, and critical issues in assessment. Emphasis on creating classroom-level assessment systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDEP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (EDIT)

EDIT 4614 - Instructional Technology: Audio-visual and Computer Uses (3 credits)
An introductory instructional technology course. Principles and production of audio-visual materials and methods in instruction. Application of microcomputers in instruction, emphasizing computer literacy, programming and evaluation of instructional software. Course in methods of teaching, field teaching experience, or teaching experience required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

EDIT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDIT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (EDTE)

EDTE 1004 - Introduction to Integrative STEM Education (3 credits)
Introduction to creative hands-on problem-solving using technological and engineering design and application. Comprehensive views of how technology and engineering require integration of knowledge to solve technological challenges. Intersection of science, technology, engineering, and mathematics (STEM) with society. Use of virtual and hands-on modeling to identify, evaluate, and test the proper materials and processes for product design. Professional skills such as problem-solving, collaboration, and effective communication.
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 1014 - Teaching Technology, Engineering, and Design (3 credits)
Introduction to strategies for teaching technology, engineering, and design in middle and high schools. Exploration of state standards and national recommendations for teaching technology, engineering, and design. Curriculum design and pedagogical frameworks for teaching technological and engineering design-based learning activities, implementing differentiated instruction, and addressing industry trends.
Prerequisite(s): EDTE 1004 or ENGE 1215 or ENGE 1414
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2005 - Engineering Technologies (3 credits)
Fundamentals of technology and engineering design for middle and high school technology educators. 2005: Human needs and cultural context in engineering design process and design thinking. Contributions of systems engineering. Knowledge and skills for processing common materials. Introduction to computer-aided design for two and three-dimensional modeling. Laboratory safety. 2006: Technology and engineering practices. Measurement, analysis, and simulation tools and techniques. Advanced materials processing. Application of computer-aided design for two and three-dimensional modeling. Teaching technology in 6th through 12th grade classrooms.
Prerequisite(s): EDTE 1014
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2006 - Engineering Technologies (3 credits)
Fundamentals of technology and engineering design for middle and high school technology educators. 2005: Human needs and cultural context in engineering design process and design thinking. Contributions of systems engineering. Knowledge and skills for processing common materials. Introduction to computer-aided design for two and three-dimensional modeling. Laboratory safety. 2006: Technology and engineering practices. Measurement, analysis, and simulation tools and techniques. Advanced materials processing. Application of computer-aided design for two and three-dimensional modeling. Teaching technology in 6th through 12th grade classrooms.
Prerequisite(s): EDTE 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2204 - Emerging Issues in Technology and Engineering (3 credits)
Examination of current and projected technology and engineering topics that are growing in regional, state, national, and global importance. Analyzing how the Grand Challenges for Engineering shape future technological advancements and their impact on societies, the environment, and global issues. Development, revision, and field-testing of appropriate learning activities for middle and high school students in selected topic areas.
Prerequisite(s): EDTE 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 2964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 3204 - Robotics Education (3 credits)
Introduction to designing robotic systems including sensors, electronic components, and mechanical devices. Foundational technical developments in the use of robots and other computer-controlled devices including technical reporting. History and evolution of robots and automation and their social, economic, industrial, and educational impacts. Robotics-based instruction for middle and high-school students.
Prerequisite(s): EDTE 2006 and CS 1014 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 3964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4204 - Capstone in Technology and Engineering Education (3 credits)
Workforce experience in technology and engineering education, including open-ended research, design, and industry collaboration. Open-ended and team-focused challenges in STEM contexts. Design-cycle (from problem identification to prototype and technical reporting) based on global, economic, environmental, and societal challenges. Comprehensive instructional unit planning to prepare pre-service educators to teach technological and engineering design-based learning to middle and high school students.
Prerequisite(s): EDTE 2204 and EDTE 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

EDTE 4754 - Internship in Education (1-16 credits)
Planned program of clinical practice in education under the direction and supervision of a university supervisor and a selected practitioner. Recommendation of program area and successful completion of Professional Studies required.
Instructional Contact Hours: (1-16 Lec, 1-16 Crd)
Course Crosslist: ALS 4754

EDTE 4964 - Field Study/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

EDTE 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Career and Technical Education - Agricultural Education Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDCI 2574	Social Foundations of Education	3
EDCI 3144	Education of Exceptional Learners	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
or ALS 1234	CALS First Year Seminar	
ALCE 2094	Introduction to Metal Fabrication	1
ALCE 2484	Engine and Power Train Technology	3
ALCE 4064	Ag Mechanical Lab Management	3
APSC 1454	Introduction to Animal and Poultry Science	3
CSES 3114/ GEOS 3614	Soils	3
EDCT 2604	Introduction to Career and Technical Education	3
ALCE/EDCT 4884	Youth Program Management	3
Subtotal		20
In addition to the courses above, the VDOE requires those seeking licensure in Agricultural Education have at least 7 hours towards one content area to make an emphasis. Pick one emphasis area: ANIMAL SCIENCE or HORTICULTURE. Then, take the additional courses below for your chosen concentration to fulfill the content emphasis requirement.		7-8
Animal Science Emphasis		
ALS 2304	Comparative Animal Physiology and Anatomy	
ALS 2504	Animals in Society	
Horticulture Emphasis		
HORT 2224	Horticulture Science and Industry	
HORT 2244	Plant Propagation	
HORT 4334	Greenhouse and Controlled Environment Agriculture Management	
Subtotal		7-8
Field-Based Requirements		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCT 4624	Managing a Career and Technical Education Program	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	6
Subtotal		18
Free Electives		**8**
Subtotal		8
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3624	Communicating Ag and Life Sciences in Writing	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
AAEC 1006	Economics of the Food and Fiber System	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
FREC 2004	Forest Ecosystems	3
Select one of the following: (Based on your emphasis)		4
Horticulture Emphasis		
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	

Animal Science Emphasis		
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	
Pathways Concept 5 - Quantitative and Computational Thinking		
STAT 2004	Introductory Statistics (5f)	3
MATH 1014	Precalculus with Transcendental Functions (5f)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
HORT 2164	Floral Design [2]	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		46
Total Credits		**120-121**

[1] Unless otherwise indicated, all courses must be taken on an A-F basis; courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree

[2] Additional fee required

Satisfactory Progress Toward Degree

University Policy 91[1] requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

3 unless otherwise indicated, all courses must be taken on an A-F basis; courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree.

[1] https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf

Graduation Requirements

Credits and GPA- Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI, EDCT, and EDEP courses)
Prerequisites - Some courses listed may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.
Additional Requirements - Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

Career and Technical Education Major with Business and Information Technologies Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDCI 2574	Social Foundations of Education	3
EDCI 3144	Education of Exceptional Learners	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
EDCT/ALCE 4884	Youth Program Management	3
EDCT 2604	Introduction to Career and Technical Education	3
Field-Based Requirements		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	6
EDCT 4624	Managing a Career and Technical Education Program	3
Subtotal		25
Option Required Courses		
ACIS 2115	Principles of Accounting	3
ACIS 2116	Principles of Accounting	3
HTM/MGT 2314	Introduction to International Business	3
MGT 1104	Foundations of Business	3
MGT 3304	Management Theory and Leadership Practice	3
Subtotal		15
Free Electives		
Select 17 credits of Free Electives		17
Subtotal		17
Pathways to General Education [1]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3844	Writing and Digital Media (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
STS 2664	Technology Ethics	3
STS 2604	Introduction to Data in Social Context	3
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
FIN 3054	Legal and Ethical Environment of Business	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select 6 credits of Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6

Pathways Concept 5 - Quantitative and Computational Thinking		
FIN 2114	Investments and Financial Literacy (5f)	3
CS 1014	Introduction to Computational Thinking (5f)	3
AAEC 2104	Personal Financial Planning (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
MGT 2064	Foundations of Entrepreneurship (6a)	3
CS 2114	Software Design and Data Structures (6d)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 fulfilled by STS 2664		
Subtotal		42
Total Credits		**120**

Satisfactory Progress Toward Degree

University Policy 91 requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

[1] https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf

Graduation Requirements

Credits and GPA

Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites

Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements

Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

Career and Technical Education Major with Family and Consumer Sciences Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDCI 2574	Social Foundations of Education	3
EDCI 3144	Education of Exceptional Learners	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
EDCT 2604	Introduction to Career and Technical Education	3
EDCT/ALCE 4884	Youth Program Management	3
Field-Based Requirements		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	6
EDCT 4624	Managing a Career and Technical Education Program	3
Subtotal		25
Option Required Courses		
HD 1004	Childhood and Adolescence	3
HD 2004	Adulthood and Aging	3
HD 2304	Family Relationships	3
HNFE 1004	Foods, Nutrition And Exercise	3
HTM 3414	Chef Lab: Culinary Operations Management [2]	4
HTM 4414	Restaurant Management: Design and Innovation	3
RED 2644	Housing and the Consumer	3
Subtotal		22
Free Electives		**10**
Subtotal		10
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
COMM 2004	Public Speaking (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AHRM 2404	Consumer Rights	3
FMD 1204	Clothing and People (Also Counts as Concept 7)	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
CONS 2304	Consumer and Family Finances (5f)	3
AAEC 2104	Personal Financial Planning (5a)	3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
AHRM 1014	Design and Art for Consumers (6a)	3
AHRM 2014	Design for Consumers Studio (6d)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 fulfilled by FMD 1204		

Subtotal	42
Total Credits	**120**

Satisfactory Progress Toward Degree

University Policy 91[1] requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

Graduation Requirements

Credits and GPA

Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites

Some courses may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements

Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

Career and Technical Education Major with Marketing Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDCI 2574	Social Foundations of Education	3
EDCI 3144	Education of Exceptional Learners	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
EDCT 2604	Introduction to Career and Technical Education	3
EDCT/ALCE 4884	Youth Program Management	3
Field-Based Requirements		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	6
EDCT 4624	Managing a Career and Technical Education Program	3
Subtotal		25
Option Required Courses		
MGT 1104	Foundations of Business	3
MGT 3304	Management Theory and Leadership Practice	3
MKTG 3104	Marketing Management	3
MKTG 3504	Advertising	3
MKTG 4554	Principles of Professional Selling	3
MKTG 4604	Retail Management	3
MKTG 4704	International Marketing	3
Subtotal		21
Free Electives		
Select 11 credits of Free Electives		11
Subtotal		11
Pathways to General Education [2]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1f)	3
ENGL 1106	First-Year Writing (1f)	3
COMM 2004	Public Speaking (1a)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
STS 2664	Technology Ethics	3
STS 2254	Innovation in Context	3
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
AHRM 2404	Consumer Rights	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits of Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
FIN 2114	Investments and Financial Literacy (5f)	3
CS 1014	Introduction to Computational Thinking (5f)	3
AAEC 2104	Personal Financial Planning (5a)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
HTM 3424	Event Management (6d)	3
CS 2114	Software Design and Data Structures	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathways Concept 7 fulfilled by STS 2664		
Subtotal		42
Total Credits		**120**

Satisfactory Progress Toward Degree

University Policy 91 requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

Graduation Requirements

Credits and GPA

Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites

Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements

Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

Elementary Education (PK-6) Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
EDCI 1004	Introduction to Teacher Education and Licensure	1
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDCI 2574	Social Foundations of Education	3
EDCI 3144	Education of Exceptional Learners	3
EDCI 3234	Foundations of Reading Instruction (PK-6)	3
EDCI 3244	Curriculum and Instruction in Elementary Mathematics, PK-3	3
EDCI 3334	Teaching Language Arts in the Elementary Classroom	4
Subtotal		20
Major Requirements		
EDCI 2464	Foundations of Social Studies Education	3
EDCI 3074	Elementary Curriculum: Methods in Teaching	3
EDCI 3254	Elementary Methods in Science	3
EDCI 3354	STEM in Elementary Schools	3
EDCI 3464	Elementary Social Studies Teaching Methods	3
EDCI 4074	Culturally Responsive Teaching in the Elementary Classroom	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
MATH 1614	Numbers and Operations for Teachers	3
MATH 1624	Geometry for Teachers	3
Field-Based Requirements		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	9
Subtotal		45
Free Electives		
Select 13 credits		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
HIST 1115	History of the United States (also meets Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States requirement)	3
or HIST 1116	History of the United States	
Select three hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
GEOG 1014	World Regions	3
HD 1004	Childhood and Adolescence	3
or PSYC 2034	Developmental Psychology	
Pathways Concept 4 - Reasoning in the Natural Sciences		
ISC 1005	Integrated Scientific Reasoning	3
ISC 1006	Integrated Scientific Reasoning	3
Option Required Courses - Select two introductory science courses from two different content areas including BIOL, CHEM, ENSC, GEOS, ISC, or PHYS; you must complete two courses from different content areas. Ex: BIOL XXXX + GEOS XXXX		
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
EDCI 4244	Curriculum and Instruction in Middle School Mathematics (4-8) (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
HIST 1115	History of the United States (also meets Pathways Concept 2 - Critical Thinking in the Humanities requirement)	
or HIST 1116	History of the United States	
Subtotal		42
Total Credits		**120**

Satisfactory Progress Toward Degree

University Policy 91[1] requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

[1] https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf

Graduation Requirements

Credits and GPA – Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites: Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements – Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

English Language Arts Education Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
EDCI 2574	Social Foundations of Education	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 3144	Education of Exceptional Learners	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
ENGL 2534	American Literary History	3
ENGL 2544	British Literary History	3
ENGL 3324	Acts of Interpretation	3
World Literature		
ENGL 3514	Ethnic Literature for Children	3
or ENGL 3694	Topics in World Novels	
History of the English Language		
ENGL 4054	History of the English Language	3
Writing		
ENGL 2604	Introduction to Critical Reading	3
Select one of the following:		3
ENGL 3315	Playwriting	
ENGL 3704	Creative Writing: Fiction	
ENGL 3714	Creative Writing: Poetry	
ENGL 3724	Creative Writing: Creative Non-fiction	
ENGL 3764	Technical Writing	
ENGL 3804	Technical Editing and Style	
Underrepresented Authors		
Select two of the following:		6
ENGL 2644	Introduction to African-American Literature	
ENGL 2804	Contemporary Native American Literatures	
ENGL 3364	Topics in Literature by Women	
ENGL 3514	Ethnic Literature for Children	
ENGL 3654	Ethnic American Literature	
Secondary Teaching Practicum		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	9
Subtotal		46
Free Electives		
Select 8 credits of Free Electives		8
Subtotal		8
Pathways to General Education [2]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3134	Gender and Linguistics (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
ENGL 4164	Studies in Shakespeare	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
ENGL 3144	Language and Ethnicity in the United States	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select six credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
ENGL 2744	Introduction to Creative Writing	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

Satisfactory Progress Toward Degree

University Policy 91 (https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf)requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in major GPA of 3.0, and be accepted into the educator preparation program.

Graduation Requirements

Credits and GPA- Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites - Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements - Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

History and Social Sciences Education Major

Code	Title	Credits
Degree Core Requirements [1]		
EDCI 2574	Social Foundations of Education	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 3144	Education of Exceptional Learners	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
Subtotal		21
Major Requirements		
EDCI 1004	Introduction to Teacher Education and Licensure	1
Virginia/South History		
HIST 3224	History of Virginia	3
World History		
HIST 1215	Intro to World History	3
HIST 1216	Intro to World History	3
History Depth Electives		
Select two from list of approved courses		6
Political Science Depth Electives		
PSCI/IS 1024	Comp Gov & Politics	3
Select one from list of approved courses		3
Virginia State and Local Government Civics Module (online) [2]		
Research Methods		
HIST 2004	Historical Methods	3
or PSCI 2024	Research Methods in Political Science	
Secondary Teaching Practicum		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education (This course should be entitled Exploring the Teaching Profession (title change approved spring of 2023))	3
EDCI 3964	Field Study	6
EDCI 4964	Field Study	9
Subtotal		43
Free Electives		
Select 11 credits of Free Electives		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
HIST 1115	History of the United States	3
HIST 1116	History of the United States	3
Pathways Concept 3 - Reasoning in the Social Sciences		
GEOG 1014	World Regions [3]	3
PSCI/GEOG/IS 2064	The Global Economy and World Politics [4]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
GEOG 1084	Digital Planet	3
Select three hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
PSCI 1014	Introduction to United States Government and Politics	3
Subtotal		45
Total Credits		**120**

1. Unless otherwise indicated, all courses must be taken on an A-F basis; courses satisfying degree core requirements may not be doubled counted to satisfy other areas of a degree.
2. Not for course credit, certificate of successful completion is part of formal acceptance into teacher preparation program
3. Students may take GEOG 1004 Introduction to Human Geography to meet the Pathways requirement, but they will also be required to take GEOG 1104 Introduction to Environmental Geography to meet licensure requirement
4. Or ECON 2005 Principles of Economics

Approved History Depth Courses

Code	Title	Credits
HIST/AFST 2275	African-American History [1]	3
or HIST/AFST 2276	African-American History	
HIST 3144	American Environmental History [1]	3
HIST 3564	The Cold War [1]	3
RLCL 1214	The Medieval World [1]	3
HIST 1515	History of Africa	3
or HIST 1516	History of Africa	
HIST 2104	Topics and Critical Issues in US History	3
HIST 2114	Topics and Critical Issues in European History	3
HIST 2124	Topics and Critical Issues in World History	3
HIST 2345	History of the Middle East	3
HIST 2364	History of Japan	3
HIST/RLCL 2384	Gandhi in the Making of Modern India	3
HIST/STS 2715	History of Technology	3
HIST 3004	Colonial America	3
HIST 3014	The American Revolution	3
HIST 3054	The American Civil War	3
HIST 3064		3
HIST 3084	Recent America, 1917-Present	3
HIST 3234	The North American West	3
HIST 3304	The World of Alexander the Great	3
HIST 3334	The Renaissance World, 1350-1500	3
HIST 3344	Early Modern and Reformation History, 1500-1650	3
HIST 3364	The Age of Revolution and Napoleon	3
HIST 3544	World War II	3
HIST 3554	Age of Globalization	3
HIST 3714	War and Medicine	3
HIST 3774	Digital History	3
HIST 2355	History of China	3

1 Preferred

Approved Political Science Depth Courses

Code	Title	Credits
PSCI 2014	Introduction to Political Theory	3
PPE 2894	PPE Gateway Course	3
PSCI 3015/3016/ PHIL 3015/3016	Political Theory	3
PSCI 3334	Judicial Process	3
PSCI 3424	State and Local Government	3

Satisfactory Progress Toward Degree

University Policy 91[1] requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

[1] https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf

University Policy 91 requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

Graduation Requirements

Credits and GPA

Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites

Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements

Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

Mathematics Education Major

Code	Title	Credits
Degree Core Requirements [1]		
EDCI 2574	Social Foundations of Education	3
EDCI 4554	Educating Exceptional Learners	3
EDCI 4724	Secondary School Teaching Methods I	3
EDCI 4734	Adolescent Literacy and Reading	3
EDCI 4744	Secondary School Teaching Methods II	3
EDEP 2374	Educational Psychology for PK-12 Teachers	3
EDEP 3474	Principles and Practices in PK-12 Assessment	3
Subtotal		21
Major Requirements		
MATH 1004	Discovering Mathematics I	1
MATH 1044	Discovering Mathematics II	2
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 3034	Introduction to Proofs	3
MATH 3124	Modern Algebra	3
MATH 3224	Advanced Calculus	3
MATH 4044	History of Mathematics	3
MATH 4334	College Geometry	3
MATH 4625	Mathematics for Secondary Teachers	3
MATH 4626	Mathematics for Secondary Teachers	3
EDCI 4244	Curriculum and Instruction in Middle School Mathematics (4-8)	3

Computer Programming

Select one of the following:		3
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Secondary Teaching Practicum		
EDCI 3964	Field Study	6
EDCI 4964	Field Study	9
Subtotal		51
Free Electives		
Select one credit of free electives		1
Subtotal		1
Pathways to General Education [2]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
STAT 3005	Statistical Methods (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 Unless otherwise indicated, all courses must be taken on an A-F basis; courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree.

2 Unless otherwise indicated, all courses taken to satisfy Pathways General Education must be taken on an A-F basis.

Satisfactory Progress Toward Degree

University Policy 91[1] requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

1 https://policies.vt.edu/91-eligibility-for-continued-enrollment.pdf

University Policy 91 requires a student to make satisfactory progress towards a degree. Additionally, licensure programs require that by the time a student has completed 72 credits, they must have passed all licensure examinations, carry an in-major GPA of 3.0, and be accepted into the educator preparation program.

Graduation Requirements

Credits and GPA- Completion of a minimum of 120 credits with a minimum overall GPA of 2.5; and in-major GPA of 3.0. (In major GPA includes all EDCI and EDEP courses)

Prerequisites - Some courses listed on this checksheet may have pre-/co-requisites; please consult the University Course Catalog or check with your advisor.

Additional Requirements - Students must submit passing scores on required state licensure examinations.

Language Study Requirement

Students who do not complete two years of a single foreign or classical language or American Sign Language in high school, may do so by taking six credits of college-level foreign or classical language or American Sign Language. The six credits used to meet this requirement may not be used to satisfy the minimum number of credits required for graduation.

School of Public and International Affairs

Our Website (https://www.spia.vt.edu/undergrad/)

Overview

School of Public and International Affairs (SPIA) provides opportunities for students interested in public issues to gain perspectives and skills from several related disciplines. SPIA is a school within the College of Liberal Arts and Human Sciences, and is comprised of the Center for Public Administration and Policy (CPAP), the Government and International Affairs (GIA) Program, the Urban Affairs and Planning (UAP) Program, and the SPIA Undergraduate Program that offers a B.A. in Public and Urban Affairs (PUA) and two majors in Smart and Sustainable Cities (SSC) and Environmental Policy and Planning (EPP).

SPIA also provides a Washington, D.C. Semester in Global Engagement (during the Spring semester) and a Washington, D.C. Semester in Leadership through Policy and Governance (during the summer session). Information on the SPIA Undergraduate Program can be obtained from the SPIA website. Information on graduate degrees may be obtained from the Center for Public Administration and Policy, and from the Government and International Affairs and Urban Affairs and Planning programs.

B.A. in Public and Urban Affairs

Smart and Sustainable Cities Major (SSC)

The Smart and Sustainable Cities (SSC) major is one of the first majors of its kind in the United States. In the major, students will learn the dynamics of urban change across time, space, and place. Students will gain a deep understanding of sustainable urban development and how smart technology and urban analytics can be combined to create solutions for the cities of the future.

The core of the major consists of two parallel tracks. The first track focuses on urban analytics and decision-making. In this track, students will develop modeling and data visualization skills that can be applied to understand urban and regional systems in data-driven, quantitative, and computational ways.

The second track focuses on sustainable urbanization and the future of cities. Students in this track will study the process of urbanization. Specific attention is given to the interdependence of social, economic, environmental, and technological factors and how these evolve over time.

Both of these tracks are then integrated through a course on data and the art of decision-making and a degree capstone studio where students apply their knowledge to real problems.

Environmental Policy and Planning Major (EPP)

Promoting sustainable human interaction with the natural environment continues to be one of the critical challenges facing societies around the world. While science and technology are critical to meeting this challenge, they must be supported by policies and plans responsive to diverse political, economic, sociocultural, institutional, and regulatory contexts.

The Environmental Policy and Planning (EPP) major provides students with an interdisciplinary framework to view environmental problems. Students will obtain the knowledge and skills needed to function as policymakers and planners who can understand complex environmental issues and develop enduring solutions.

The EPP major builds on the Public and Urban Affairs (PUA) degree core that provides students with foundational knowledge in policy, planning, governance, and international affairs. The EPP major extends this knowledge through an interconnected sequence of courses that explore environmental policy and planning, land use, and environmental law. EPP students will also develop their expertise by selecting one more elective from three subject areas: Policy; Planning; and Environment and Conservation.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Pathways) (see "Academics (p. 9)") and toward the degree in Public and Urban Affairs.

Satisfactory progress requirements toward the B.A. in Public and Urban Affairs can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Environmental Policy and Planning Major (p. 1146)
- Smart and Sustainable Cities Major (p. 1148)
- Urban Affairs and Planning (p. 1149)

Undergraduate Program Director: Steven Hankey
Professors: A. Ahram, R. Buehler, R. Hall, and M. Stephenson
Associate Professors: D. Bieri, M. Cowell, S. Davis, D. Giselle, S. Hankey, S. Misra, T. Schenk, D. Zahm, and Y. Zhang
Assistant Professors: C. Levinson, T. Lim, P. Wagle
Adjunct Professors: B. Anderson, S. Mastran, J. Provo, and M. E. Ridenour

Undergraduate Course Descriptions (SPIA)

SPIA 1024 - Community Service Learning (3 credits)
An introduction to community service learning with emphasis on the development of civic agency. Critical perspectives on community, ethical community engagement, service and volunteerism, servant leadership, and social change. Exposure to the socio-political dynamics inherent in community development and problem solving. Includes significant community engagement and service-learning experiences, reflection, and the development of a personal community engagement action plan.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 1044 - Life in the Built Environment (3 credits)
Development of the human-made environment has shaped our social relations, culture, and identity. Discussion of how the imposition of built form has served both to define a shared culture and as a means of exclusion and injustice. Study of equity and ethics as evidenced and continued in planning, construction, and public space. Learn how the knowledge of these past structures might shape the future of the built environment in the United States in ways that are more equitable, inclusive, and sustainable.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARCH 1044

SPIA 2004 - Introduction to Urban Analytics (3 credits)
Computational and quantitative thinking applied to urban problems. Multiple data sources and tools for urban analysis. Application of computational and quantitative thinking in decision making and policy processes. Data cleaning, joining/merging, and summarizing. Evaluation of computational and quantitative thinking in urban planning and policy. Ethical and other issues related to computing, analysis and problem solving.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2024 - Community Systems Thinking (3 credits)
Introduction to systems thinking concepts and their application to community-based problem solving and decision making. Emphasis on identifying interactions between technical and contextual dimensions of persistent, complex global problems. Introduces systemic frameworks for defining problems, identifying and engaging stakeholders, ideating interventions, selecting and employing criteria for decision making, and creating feedback mechanisms for iterative design. Ethics of community engagement is considered. Includes problem- based service-learning projects.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2114 - Public Service Leadership (1 credit)
Definition and practice of leadership in the public and nonprofit sectors, and its relationship to democratic governance. Decision-making under varying degrees of certainty and ambiguity. Exploring the relationship between public values and the public interest. Evidence for decisions. Case study engagement and presentation.
Instructional Contact Hours: (1 Lec, 1 Crd)

SPIA 2124 - The Art & Science of Negotiation (3 credits)
Practical negotiation techniques and tactics. Tools to systematically assess and prepare for negotiations, including option evaluation and understanding counterparts. Interpersonal skills for effective engagement. Multiparty negotiations. Ethical and moral issues in negotiations. Representation and principle-agent issues. Negotiation process design. Facilitation and mediation. Tackling scientifically and technically complex disputes. Various models, with an emphasis on the mutual gains approach to negotiation.
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2244 - Sustainable Urbanization (3 credits)
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. Fee $30.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2244

SPIA 2314 - Active Transportation for a Healthy, Sustainable Planet (3 credits)
Connections among active transportation (e.g., bicycling, walking) and significant global challenges such as physical inactivity, health, the environment, and the economy on local to global scales. Methods to assess walkability among communities with different worldviews and the influence of the built environment on rates of active transportation. Approaches to evaluate demographic and psychosocial predictors and physical and policy barriers to use of active transportation. Successful strategies to increase active transportation through community design guidelines, behavior change tools, transportation planning, and policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 2314

SPIA 2544 - Policy Dynamics in Global Health (3 credits)
Overview of global health problems and policy. Key actors and socio-political dynamics that shape knowledge and action on global health issues. Roles and responsibilities in global health policymaking.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2554 - Collaborative Policy-Making and Planning (3 credits)
Introduction to multi-stakeholder collaboration and public participation in planning, policy-making and public administration. Tools and approaches for engagement and effective collaboration. Deliberative and participatory democracy, and transparency in society. Information sharing and access. Civil society, the media and citizen activism. Ethical and moral issues in collaboration. Barriers to participation, and diversity and inclusion.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 3554 - Transdisciplinary Problem Solving for Social Issues (3 credits)
Strategies and skills for transdisciplinary problem solving. Emphasis on integrative thinking strategies and cognitive and interpersonal skills required to bridge scientific discipline-based, non-scientific discipline-based and cultural knowledge. Strategies to identify important disciplinary, non-scientific, ethical, cultural, and structural elements of a problem. Problem-based learning, ethics, team work, and effective communication skills.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 3704 - Urban Contention and Mobilization (3 credits)
Analyzes the emergence and impact of contentious mobilization in the U.S. and global cities. Includes civil and labor rights, religious freedom, democratization, and other movements for equity and inclusion. Explores social scientific approaches to mobilization, countermobilization, and collective action. Impact of contentious mobilization on governance and planning in urban sites and spaces worldwide. Examines how movements manage and address internal diversity, including variation in members' diverse experiences and objectives.
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

SPIA 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4374 - Federal Cybersecurity Policy and Regulation (3 credits)
This course seeks to give students an understanding of how the government develops new cybersecurity regulations and policies that balance consumer interest in personal protection with industry attitudes towards oversight. The course also covers the policies that government entities take in the interest of national security to maintain state secrets in the face of threats from hackers and other hostile actors.
Prerequisite(s): FIN 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4454 - Future of Cities (3 credits)
Cities as complex systems. Interdependence of social, economic, environmental, and technological components and how these change over time. Theories about city formation, structure, and change, with implications for sustainability, resilience, and globalization.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4464 - Data and the Art of Policy-Making and Planning (3 credits)
Critical examination of use of scientific and technical information in planning and policy-making, exploring issues and challenges through social science lens. Investigation of appropriate and responsible use of data within collaborative and deliberative policy-making and planning processes. Presentation of data and underlying models in accessible and understandable formats. Integrating all forms of knowledge into decision-making, including local and traditional knowledge.
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, FREC 4554, HORT 4554, LAR 4554

SPIA 4724 - CyberLeaders Capstone (6 credits)
Interdisciplinary research and analysis from technical and policy standpoints of regulation and industry standards, leading to the development and communication of possible solutions for specific cybersecurity problems related to critical systems. Previous topics include cellphone encryption and Internet of Things security.
Corequisite(s): SPIA 4374
Instructional Contact Hours: (2 Lec, 12 Lab, 6 Crd)

SPIA 4784 - Community Systems Capstone (3 credits)
Collaborative community problem solving in team environments Data collection, interpretation, and presentation augment community-based, iterative design and planning processes. Consideration of ethical engagement and community goals related to social justice, resilience, and sustainability. Discourse-based project culminating in presentation of intervention proposals to stakeholders. Pre: 3 credits in Discourse.
Prerequisite(s): (SPIA 1024 or SOC 2034) and SPIA 2024
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SPIA 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SPIA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Environmental Policy and Planning Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
UAP 1004	Introduction to Career & Professional Development in Public Service	1
UAP 1024	Leadership, Service, and Public Problem Solving	3
PSCI 1014	Introduction to United States Government and Politics	3
STAT 3604	Statistics for Social Science	3
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	3
UAP/PSCI 3744	Public Policy Analysis	3
UAP 3024	Urban and Regional Analysis	3
UAP 3224	Policy Implementation	3
UAP 4754	Legal Foundations of Planning	3
UAP 4914	Seminar in Public and Urban Affairs	3
UH 4514	Honors SuperStudio	1
Subtotal		29
Major Requirements		
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 3014	Urban Policy and Planning	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3
UAP 4354	Interdisciplinary Environmental Problem Solving Studio	3
Subtotal		15
Elective Courses		
Select nine hours (at least one from each of the Competency areas):		9
Policy		
UAP/PSCI 3714	The U. S. Policy Process	
UAP 3954	Study Abroad	
UAP/PSCI 4624	The Washington Semester: Seminar in American Politics and Public Policy	
UAP/PSCI 4644	Washington Semester: Politics, Policy and Administration in A Democracy	
SPIA 4954	Study Abroad	
SPIA 4964	Field Work/Practicum	
SPIA 3704	Urban Contention and Mobilization	
HD 3024	Community Analytics	
AAEC 3314	Environmental Law	
LAR 4034	Evolution of the American Landscape	
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	
PSCI 3424	State and Local Government	
PSCI 3434	Urban Politics	
AAEC 3324	Environment and Sustainable Development Economics	
ECON 4014	Environmental Economics	
LAR 2254	Social and Cultural Landscapes	

Planning		
GEOG 2084	Principles of Geographic Information Systems	
GEOG/GEOS 4084	Modeling with Geographic Information Systems	
UAP 3024	Urban and Regional Analysis	
UAP/GEOG/SOC 4764	International Development Policy and Planning	
UAP 4854	Planning of the Urban Infrastructure	
UAP 4394	Community Renewable Energy Systems	
SPIA/GEOG 2244	Sustainable Urbanization	
SPIA/HNFE 2314	Active Transportation for a Healthy, Sustainable Planet	
UAP 4964	Field Study	
LAR 3044	Land Analysis and Site Planning	
SBIO 3324	Green Building Systems	
Environment & Conservation		
LAR 1254	Environment and Natural Systems	
FREC 1044	Introduction to Environmental Data Science	
FREC 2004	Forest Ecosystems	
FREC 2124	Forests, Society & Climate	
FREC/HORT 2134	Plants and Greenspaces in Urban Communities	
FREC 4454	Urban and Community Forestry	
STS 3334	Energy and Society	
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 3104	Environmental Justice, Resources and Development	
SPIA 4454	Future of Cities	
Subtotal		9
Bridge Experience		
SPIA 3900	Bridge Experience (with one of the following)	0
CEP 3084	University Internship	0
or CEP 4084	Cooperative Education Program	
or SPIA 4954	Study Abroad	
or SPIA 4964	Field Work/Practicum	
or UAP 3954	Study Abroad	
or UAP 4624	The Washington Semester: Seminar in American Politics and Public Policy	
or UAP 4964	Field Study	
or UAP 4994	Undergraduate Research	
Free Electives		
Select as many credits needed to reach 120 credits		21
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
ENGL 1106	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
PHIL 1304	Morality and Justice	3
or PHIL 2304	Global Ethics	
Select three additional credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Pathways Concept 4 - Reasoning in the Natural Sciences		
ENSC 1015 & ENSC 1016	Foundations of Environmental Science and Foundations of Environmental Science	6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1014	Precalculus with Transcendental Functions (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	3
Select three additional credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SPIA 2554	Collaborative Policy-Making and Planning	3
Subtotal		45
Total Credits		**119**

Satisfactory Progress

To make satisfactory progress within the EPP major, students must complete UAP 1024 Leadership, Service, and Public Problem Solving, PSCI 1014 Introduction to United States Government and Politics, STAT 3604 Statistics for Social Science, and UAP 3354 Introduction to Environmental Policy and Planning by the end of the semester in which 60 hours have been attempted; and maintain an in-major GPA of 2.0.

Graduation Requirements

Hours Requirement

Students must earn at least 120 credit hours to graduate with a PUA degree.

In-major GPA

All courses in the Degree Core and Major Requirements are included in the in-major GPA calculation. A GPA of 2.0 or above (overall and in-major) is required for graduation.

Dual Use of Courses

No course can double count within or between SPIA-related majors or minors with the exception of the Core Degree Requirements. In accordance with university guidelines, courses satisfying degree core requirements may not be used to satisfy other areas of a degree (e.g. Pathways).

Intra-SPIA Program Majoring and Minoring

Students may pursue more than one major or minor associated with the School of Public and International Affairs Program. In this case, the policy pertaining to the "Dual Use of Courses" will apply.

Prerequisites

Some courses listed on this checksheet have prerequisites. Be sure to consult the University Catalog and/or check with your advisor regarding course planning.

Foreign Language Requirement

University and Admissions Foreign Language Requirement

2 years of a single foreign, classical, or sign language in high school ***or complete an 1105-1106 series of foreign language - (these credits will not count toward the 120 required for graduation).***

Smart and Sustainable Cities Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Required Courses		
UAP 1004	Introduction to Career & Professional Development in Public Service	1
UAP 1024	Leadership, Service, and Public Problem Solving	3
PSCI 1014	Introduction to United States Government and Politics	3
STAT 3604	Statistics for Social Science	3
SPIA 3554	Transdisciplinary Problem Solving for Social Issues	3
UAP 4754	Legal Foundations of Planning	3
UAP 3224	Policy Implementation	3
UAP/PSCI 3744	Public Policy Analysis	3
UAP 3024	Urban and Regional Analysis	3
UAP 4914	Seminar in Public and Urban Affairs	3
UH 4514	Honors SuperStudio	1
Subtotal		29
Major Requirements		
Required Core Courses		
SPIA 2004	Introduction to Urban Analytics (Covers Pathway 5a)	3
SPIA/GEOG 2244	Sustainable Urbanization	3
SPIA 4464	Data and the Art of Policy-Making and Planning (Covers Pathway 5a)	3
SPIA 4454	Future of Cities	3
Subtotal		12
Required Elective Courses		
Select nine credit hours from the list below		9
Subtotal		9
Bridge Experience		
SPIA 3900	Bridge Experience (with one of the following)	0
CEP 3084	University Internship	0
or CEP 4084	Cooperative Education Program	
or SPIA 4954	Study Abroad	
or SPIA 4964	Field Work/Practicum	
or UAP 3954	Study Abroad	
or UAP 4624	The Washington Semester: Seminar in American Politics and Public Policy	
or UAP 4964	Field Study	
or UAP 4994	Undergraduate Research	
Free Electives		
Select as many credits as needed to reach 120 credits		31
Subtotal		31
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
ENGL 1106	First-Year Writing	3
Select three credis in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
PHIL 1304	Morality and Justice	3
or PHIL 2304	Global Ethics	
Select three credis in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics	
AAEC 1005 & AAEC 1006	Economics of the Food and Fiber System and Economics of the Food and Fiber System	
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [1]		6
Pathways Concept 5 - Quantitative and Computational Thinking *The Pathways 5a requirement is met by completing the SSC Major core (specifically - SPIA 2004 and SPIA 4464)*		
MATH 1014	Precalculus with Transcendental Functions	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
SPIA 2554	Collaborative Policy-Making and Planning	3
Subtotal		39
Total Credits		**120**

[1] No labs are required

Required Elective Courses

Select nine (9) credit hours from the elective courses listed below. All courses listed below are 3 credit hours.

Code	Title	Credits
Urban Policy and Decision-Making		
UAP 3014	Urban Policy and Planning	3
UAP/PSCI 3714	The U. S. Policy Process	3
UAP 3264	Contemporary Urban Issues	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3
UAP 4394	Community Renewable Energy Systems	3
UAP 4854	Planning of the Urban Infrastructure	3
UAP/PSCI 4624	The Washington Semester: Seminar in American Politics and Public Policy	3
UAP/PSCI 4644	Washington Semester: Politics, Policy and Administration in A Democracy	3
SPIA 4964	Field Work/Practicum	3
SPIA/HNFE 2314	Active Transportation for a Healthy, Sustainable Planet	3
SPIA 3704	Urban Contention and Mobilization	3
HD 3024	Community Analytics	3
PSCI 3424	State and Local Government	3
PSCI 3434	Urban Politics	3
UAP 4964	Field Study	3
GIS/Data		
GEOG 2084	Principles of Geographic Information Systems	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems	3
CS 1064	Introduction to Programming in Python	3
Urban Design		
ARCH 3504	Topics in Architectural Media and Methods	3
ARCH 4324	Advanced Topics in Architectural Media and Methods	3
LAR 3044	Land Analysis and Site Planning	3
CEE 2834	Civil Engineering Drawings and Virtual Modeling	3
Cities, Culture, and Place		
LAR 2254	Social and Cultural Landscapes	3
LAR 3264	People Community and Place	3
LAR 4034	Evolution of the American Landscape	3
FREC/HORT 2134	Plants and Greenspaces in Urban Communities	3
FREC 4454	Urban and Community Forestry	3
GEOG 3244	The U.S. City	3
Economics		
UAP/REAL 2004	Principles of Real Estate	3
ECON 3024	Economic Justice	3
ECON 4014	Environmental Economics	3
AAEC 3324	Environment and Sustainable Development Economics	3
International		
UAP 3954	Study Abroad	3
UAP/SOC/GEOG 4764	International Development Policy and Planning	3
SPIA 4954	Study Abroad	1-19

Urban Affairs and Planning

Our Website (https://spia.vt.edu/programs/uap.html)

Overview

The Urban Affairs and Planning Program (UAP) offers an accelerated program that enables students to earn credit toward a Master of Urban and Regional Planning (MURP) degree while they are completing the requirements for their bachelor degrees. At the graduate level the department offers the master of urban and regional planning degree.

Accelerated Program

The Urban Affairs and Planning Program (UAP) and School of Public and International Affairs (SPIA) offers an accelerated program that enables students to earn credit toward a Master of Urban and Regional Planning (MURP) degree while they are completing the requirements for their Bachelor of Arts in Public and Urban Affairs with a major in Smart and Sustainable Cities (SSC) and/or Environmental Policy and Planning (EPP). This 4+1 five-year program provides qualified students with a unique opportunity to advance in the field of urban and regional planning.

During their senior year, admitted students will take up to 18 credit hours of graduate coursework in the MURP Program. The 18 credit hours of graduate coursework will fulfill both graduate and undergraduate requirements. At the end of their fourth year, students should have completed all undergraduate requirements to receive their bachelor's degree.

In the summer after graduating with their bachelor's degree, students will participate in either a six (6) credit hour professional internship experience with a public agency, non-profit organization or private firm working on planning issues, or an approved six (6) credit hour study abroad program, or participate in six (6) credit hours of approved graduate-level courses.

During their fifth year, students complete 24 credit hours graduate coursework required for the MURP program and earn a Master of Urban and Regional Planning degree.

Criteria for Admission

- Application: VT Graduate School application submitted by end of junior year
- Minimum GPA: 3.5 cumulative
- Test score requirements: None

Chair: Todd Schenk
Professors: R. Buehler, R. Hall, and M. Stephenson
Associate Professors: D. Bieri, M. Cowell, S. Hankey, S. Misra, T. Schenk, D. Zahm, and Y. Zhang
Assistant Professors: T. Lim and P. Wagle
Adjunct Professors: B. Anderson, S. Mastran, J. Provo, and M. E. Ridenour

Undergraduate Course Descriptions (UAP)

UAP 1004 - Introduction to Career & Professional Development in Public Service (1 credit)
This course introduces the academic requirements and potential career fields for the Environmental Policy and Planning (EPP) and Smart and Sustainable Cities (SSC) majors. It is designed to assist new and transfer students with academic planning, career exploration, and the job search process. In addition, students will develop an understanding of professional competencies and examine how these competencies relate to a potential occupational field. During the course, students will develop the materials and skills needed to successfully apply for an internship or job. These materials will include the preparation of a cover letter and resume that respond directly to a targeted position. The skills include interview and presentation techniques.
Instructional Contact Hours: (1 Lec, 1 Crd)

UAP 1024 - Leadership, Service, and Public Problem Solving (3 credits)
Current events and case studies on complex planning and policy issues challenging the United States. Historical, political, economic, social, and geographical context of the issues. Roles, relationships and responsibilities in governing, government, and the public policy process. Approaches to leadership and leadership styles. Professional ethics and the role of ethics in policy decisions. Dealing with competing values and public vs. interests in policy making.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 2004 - Principles of Real Estate (3 credits)
Introduction to real estate, including markets, land use planning and zoning, development, finance, construction, sales, marketing, management and property valuation. Examines the key actors and processes in each of these areas. Explores major public policies impacting real estate.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: REAL 2004

UAP 2114 - Sustainability by Design (3 credits)
Design decision-making in complex contexts. Ethical issues underlying design for sustainability. Evaluation of design in systems, products, places, and modes of living using the Framework for Strategic Sustainable Development (FSSD). Historical and cultural underpinnings of design and sustainability.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ARCH 2114

UAP 2334 - Urbanization and Biodiversity Conservation (3 credits)
Overview of challenges and opportunities that urban environments create for biodiversity conservation and human wellbeing, with a focus on social sciences theories and approaches. How urbanization is changing people's relationship with their environment and what that means for biodiversity conservation and human wellbeing. Examination of how data collection, analysis, and interpretation occur using social sciences methods applied to biodiversity conservation. Diversity, Equity, and Inclusion in the context of urbanization and conservation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FIW 2334

UAP 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 3014 - Urban Policy and Planning (3 credits)
An introduction to urban policy and urban planning. Includes analysis of the basic concepts and principles of urban policy, a review of urban policy in the United States, discussion of the development of urban planning and its role in shaping the urban environment, and an analysis of the relationship between public policy and planning and the organization and structure of the urban environment.
Prerequisite(s): UAP 1024
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3024 - Urban and Regional Analysis (3 credits)
Overview and application of various methods used to study, represent, understand communities in their urban and regional context. Data collection and analysis; population, land use, transportation and economic forecasting; selecting and applying an appropriate method; designing and presenting a community study. Restricted to majors and minors only.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3224 - Policy Implementation (3 credits)
Systematic analysis of the field and practice of public policy implementation. Includes analysis of the structure and dynamics of the policy process as well as specific analytic approaches to understanding policy implementation. Includes analysis of intra-organizational, interorganizational and intergovernmental implementation processes.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3264 - Contemporary Urban Issues (3 credits)
Consideration of one particular issue of immediate importance to the contemporary urban environment. Topics emphasize major social or economic policy issues, and may change each year. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3344 - Global Environmental Issues: Interdisciplinary Perspectives (3 credits)
Critical examination of major global environmental problems from a humanities perspective, including international community responses to global environmental problems such as global warming, atmospheric ozone depletion, acid rain, tropical deforestation, toxic waste. Actions by key actors in the international community to develop solutions. Relationship of justice, fairness, equality, and diversity to political questions of power or authority. Pre: 3 credits of Critical Issues in a Global Context.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3344, PSCI 3344

UAP 3354 - Introduction to Environmental Policy and Planning (3 credits)
Introduction to the interdisciplinary principles of environmental policy, planning, economics, and ethics to address pollution abatement, resources conservation, habitat protection, and environmental restoration. The course will focus on practical means of identifying environmental problems and creatively solving them.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 3434 - Public Administration (3 credits)
The role and context of public administration in the contemporary United States, administrative organization and decision-making, public finance, human resources administration, and program implementation.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3414

UAP 3444 - Administrative Law and Policy (3 credits)
The legal context of the exercise of discretion by public administrators in the United States. Adjudication and rule- making; access to administrative processes and information; legislative and judicial control of administration.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3444

UAP 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, HUM 3464, SOC 3464

UAP 3714 - The U. S. Policy Process (3 credits)
Description and analysis of the processes and institutions involved in the making and implementation of public policy in the United States, with a primary focus on domestic and economic policy. Empirical and normative models of the process of public policy making in the U.S.
Prerequisite(s): PSCI 1014
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3714

UAP 3744 - Public Policy Analysis (3 credits)
Methods and approaches used in the analysis and evaluation of public policy; strengths and limitations of various analytic tools; normative issues in the practice of policy analysis.
Prerequisite(s): PSCI 1014 or PSCI 1014H
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3744

UAP 3774 - Marxian Political Analysis (3 credits)
Contemporary uses of Marxian concepts and theories to study the world economy, business structure, current social issues, modern ethical values, and alienation.
Prerequisite(s): PSCI 2014 or PSCI 2054 or IS 2054 or GEOG 2054 or PSCI 2064 or IS 2064 or GEOG 2064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 3774

UAP 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4184 - Community Involvement (3 credits)
Issues, concepts, and techniques of citizen participation in community development. Institutional frameworks and their historical precedents. Exercises developing group communications skills, public meeting facilitation, and design of community involvement programs. Pre: Senior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4214 - Gender, Environment, and International Development (3 credits)
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4214, WGS 4214

UAP 4264 - Environmental Ethics and Policy (3 credits)
Issues in applied environmental ethics. Contributions of diverse religious and philosophical traditions to contemporary perspectives on the human-nature relationship. Examination of environmental policies from utilitarian economic, deep ecology, and ecofeminist perspectives. Junior, senior or graduate standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4344 - Law of Critical Environmental Areas (3 credits)
This course examines the legal principles and policy debates involved in the regulation and protection of critical environmental resources. Specific topics vary but will likely include wetlands law and policy, endangered species habitat, open space, forestland and farmland protection, coastal zone management, and floodplain regulation and policy.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4354 - Interdisciplinary Environmental Problem Solving Studio (3 credits)
Interdisciplinary, experiential problem-solving studio focusing on specific environmental problems. Working in groups, students interact with local officials, developers, environmental groups, and community organizations to explore the processes of environmental management, planning, and regulations. Students apply techniques and skills frequently used by environmental policymakers and planners. Pre: Senior standing.
Prerequisite(s): UAP 3354 and UAP 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4364 - Seminar in Environmental Policy and Planning (2 credits)
Critical examination of the social, political, economic, legal, scientific, and technological contexts underlying processes of environmental change, problems, and solutions, as seen from various conceptual and disciplinary perspectives. Senior status required and 9 credit hours, 3000-level or above, in the Environmental Policy and Planning major or minor.
Prerequisite(s): UAP 3354 and UAP 3224
Instructional Contact Hours: (2 Lec, 2 Crd)

UAP 4374 - Land Use and Environment: Planning and Policy (3 credits)
Environmental factors involved in land use planning and development, including topography, soils, geologic hazards, flooding and stormwater management, ecological features, and visual quality. Techniques used in conducting environmental land inventories and land suitability analyses. Policies and programs to protect environmental quality in land use planning and development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4384 - Pollution Control Planning and Policy (3 credits)
Planning and policy aspects of managing residuals and environmental contaminants and their effects on human health and environmental quality. Technical and economic factors involved in management of water quality, air quality, solid and hazardous wastes, toxic substances, and noise. Implementation of pollution control legislation, policies, and programs at federal, state, and local levels.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4394 - Community Renewable Energy Systems (3 credits)
Practical design fundamentals for small scale renewable energy systems: solar building heating and cooling; solar domestic hot water; wind, photovoltaic, and hydroelectric systems; alcohol, methane and other biomass conversion systems. Developing plans, programs, and policies to stimulate development of renewable systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4624 - The Washington Semester: Seminar in American Politics and Public Policy (3 credits)
This seminar is the integrative forum for the principal elements of the Washington Semester experience. The course explores both the role of political institutions in policy formation and implementation and the primary managerial and leadership challenges that arise for implementing organization managers in American democratic public policy-making. Pre: Junior standing or instructor consent and acceptance into the Washington Semester program.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4624

UAP 4644 - Washington Semester: Politics, Policy and Administration in A Democracy (3 credits)
This course is part of the Washington Semester. Explores the relationship between the imperatives of democratic mobilization, policy choices and organizational choices through intensive study of the operating context of a selected public or nonprofit organization. Examines implications of policy-maker choices for implementing institution dynamics and challenges. Pre: Junior standing and acceptance into the Washington Semester program required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSCI 4644

UAP 4714 - Economics and Financing of State and Local Governments (3 credits)
Examines the provision and financing of public goods and services in local governments. Analyzes associated policy issues. Reviews experience in Western Europe and developing countries, as well as in the United States.
Prerequisite(s): UAP 3024 and (ECON 2005 or ECON 2005H) and (ECON 2006 or ECON 2006H)
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4754 - Legal Foundations of Planning (3 credits)
Examination of the legal context in which urban planning and public policy operate. Legal structure, role of law, powers of sovereign governments, constitutional limitations on government activities, and public-private conflict and their influence on planning and public policy are examined. Pre: Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4764, SOC 4764

UAP 4854 - Planning of the Urban Infrastructure (3 credits)
Course examines the interdependences among the elements of the built environment of the city and those between the elements of the built environment and the policy/planning structure of the city. Considered are those elements associated with the primary urban activities (residential, commercial, industrial) as well as the urban form-giving infrastructure facilities that support those land uses (water supply, sewerage, solid waste disposal, transportation, education, recreation, health, and safety).
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4914 - Seminar in Public and Urban Affairs (3 credits)
This capstone seminar explores the central questions of the role of the citizen and the citizenry in democratic capitalistic urban societies as well as the nature of accountability in such regimes. Topics such as the processes by which representation occurs, alternate theories of democratic community and the relationship of the public, private and civil sectors in urban society are treated. Senior status in PUA required. PUA majors and minors must complete this course with a C grade or higher to graduate; otherwise course must be repeated.
Prerequisite(s): UAP 4754 and SPIA 2554 and SPIA 3554
Instructional Contact Hours: (3 Lec, 3 Crd)

UAP 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4964H - Honors Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UAP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Science, Technology, and Society

Our Website (http://www.sts.vt.edu)

Overview

The Department of Science, Technology, and Society (STS) offers interdisciplinary work at both the undergraduate and graduate levels that contributes to our understanding of the relations among science, technology, and society. At the undergraduate level, it offers four minors.

Humanities, Science, and Environment Minor (HSE)

This minor provides an interdisciplinary approach to environmental issues, integrating humanities, social sciences, and natural sciences to understand the relationship between people and the natural world.

Science, Technology, and Society (STSO)

This minor may be designed to emphasize combinations of moral, aesthetic, intellectual, political, historical, philosophical, and sociological dimensions of science, technology, and medicine, through case studies and in-depth analysis. Students work with the undergraduate coordinator in STS to design a coherent program.

Medicine and Society Minor (MSOC)

The Medicine and Society minor focuses on the humanistic aspects of medical practice, pressing bioethical questions, and the subjective experience of illness and health. The MSOC minor provides an essential education for anyone curious about the role of medicine in past eras and contemporary culture, and it provides an excellent background for those considering a career in medicine or other health care professions. The minor requires 21 credit hours with at least 14 hours at the 3000 or 4000 level.

Gender, Science, and Technology Minor (GST)

Co-developed by Women's Studies and STS, this minor offers the opportunity for students to cultivate an understanding of the complex ways in which gender is defined in relation to science and technology, and science and technology are defined in relation to gender. The minor coordinator is the Director of the Women's Studies Program.

Contact Carol Sue Slusser in 121 Lane Hall or vie email at slusserc@vt.edu, for more information or to enroll in one of these minors.

Graduate Program in Science and Technology Studies

STS jointly administers the Science and Technology Studies Graduate Program with contributing and affiliated faculty from the departments of History, Philosophy, Political Science, and Sociology. The program offers the M.S. and Ph.D. degrees at both the Blacksburg and National Capital Region campuses. (See the Graduate Catalog for further information.)

Head: Saul Halfon
Professor: J.E. Abbate and B.L. Allen
Associate Professors: D. Breslau, J. H. Collier, S.E. Halfon, A.S. Heflin, R. Hester, P.R. Olson, S. Schmid, L. Vinsel, and M. Wisnioski
Assistant Professors: J. Aggrey, M. Haines, F. Prieto-Nañez, and F. Rosa
Collegiate Assistant Professor: C. Olson
Collegiate Associate Professor: M. Goodrum
Emeritus Professor: R.M. Burian, G.L. Downey, E. Crist Patzig, E.R. Fuhrman, A.F. LaBerge, and D.T. Zallen
Director of Graduate Studies: M. Wisnioski
Director of Undergraduate Studies: L. Vinsel
Undergraduate Coordinator: Carol Sue Slusser

Undergraduate Course Descriptions (STS)

STS 1504 - Introduction to Science, Technology, and Society (3 credits)
Examination of the interrelationship among science, technology, and society. Study of how science, technology, and medicine are defined and analyzed by the humanities and social sciences. Examination of topics, theories, and methods of the field of Science and Technology Studies. Depiction of the dynamics of scientific and technological controversies including the roles knowledge, expertise, risk, rhetoric and public understanding play in policy making.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 0 Lab, 3 Crd)

STS 2034 - Introduction to Technology and Race (3 credits)
Examination of the relationship between technology and race. Technology such as information and communication technologies, medical and biometric technologies, transportation, and space travel in contexts of colonialism, indigenous knowledge, and globalization. Role of technology in resistance and emancipation. Assessment of inequity in the design and maintenance of sociotechnical systems including bias in design, surveillance, biopolitics, and the digital divide.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2054 - Engineering Cultures (3 credits)
Development of engineering and its cultural values in historical and transnational perspectives. Explores the varying knowledge, identities, and commitments of engineers and engineering across different countries. Examines values in emergent infrastructures of engineering education and work, and the participation of engineers and engineering in evolving forms of capitalism. Helps students learn to reflect critically on their knowledge, identities, and commitments in varying curricula and a globalizing world.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2054

STS 2154 - The Life Sciences and Society (3 credits)
Basic Science, Technology, and Society (STS) perspectives on the life sciences and the ethical issues they raise. Humanistic approaches to analyze how our values and perceptions are informed by the ways that we understand bodies, biology, and life itself. How our hopes, desires, and fears shape the practices and technologies of the life sciences.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2254 - Innovation in Context (3 credits)
Critical examination of diverse definitions and examples of innovation. Discussion of innovation as a process of social change; as technology diffusion; as an economic engine; as an ecosystem; as an ideology; and more. Introduction to methods and ideas from the field of Science and Technology Studies including the analysis of innovation from historical, cultural, and economic perspectives, as well as the study of innovations consequences and its alternatives. Collaborative projects focused on creatively describing and critiquing local cases of innovative work.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2444 - Global Science and Technology Policy (3 credits)
Introduction to issues and themes in global science and technology policy, from the perspective of Science and Technology Studies (STS). Comparison of national and international policy agents, institutions, structures, and processes. Integration of key ideas from STS into policy analysis, including regulatory cultures, cultural notions of risk and expertise, large socio-technical systems, and social shaping of technology. Emphasis on international controversies, diverse cultural perspectives, and inclusion in policy processes. Cases may include international controversies over genetically modified foods, transmissible illnesses, nuclear energy, and information security.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2454 - Science, Techology, and Environment (3 credits)
Examines the nature and causes of global environmental challenges. Focuses on the role of science and technology in the causation of environmental problems and provision of solutions. Investigates uneven impacts among different groups and nations. Explores multicultural dimensions and ethical debates in the relationship between humanity and natural world. Considers visions of alternative futures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2464 - Religion and Science (3 credits)
Exploration of the relationships between religion and science in the western tradition. Basic frameworks for relationships between religion and science in historical and cultural context, types of human knowledge and truth, similarities and differences between science and religion, evolution, the origins of the creationist movement, and contemporary moral and ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2464

STS 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2604, SOC 2604

STS 2664 - Technology Ethics (3 credits)
Critical, interdisciplinary exploration of ethical considerations regarding human engagements with technology, including technological development, use, success and failure. History and fundamental concepts of normative ethics and their application to specific technologies and technological systems. Emphasis on conceptualizations and representations of technology with respect to various social, cultural, and historical perspectives on nature, human nature, and technological artifacts.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 2715 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2715

STS 2716 - History of Technology (3 credits)
Development of technology and engineering in their social and cultural contexts. Examines the interaction of people, cultures, technologies, and institutions such as governments, religious bodies, corporations, and citizens groups. 2715: Examines the creation and modification of technologies to establish the basic structures of civilization, from prehistory to the Industrial Revolution (about 1800). 2716: Examines the nature of technological change and consequences in society, from about 1800 to present.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2716

STS 2724 - Introduction to Displacement Studies (3 credits)
Examines key concepts, ideas, and technologies in global population displacement, including categorization, distribution and governance of displaced groups. Introduces displacement drivers such as natural disaster, climate change, civil unrest, infectious disease, and forced relocation. Identifies digital infrastructures used for, by, and against displaced populations. Describes experiences of displaced people.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 2724, HIST 2724, LAHS 2724

STS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 3104 - Science and Technology in Modern Society (3 credits)
Examination of science and technology as social and cultural activities in the modern world. The relationship of science and technology to their social and cultural contexts. Institutions and values in science and technology. The changing relationship of technology to science. Discuss how the domain and objects of scientific investigation have been shaped by changing concepts of nature and the natural.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3124 - Societal Health in North America (3 credits)
Study of human health within and across a variety of geographic contexts in North America. Describe the health consequences of inequity and injustice within and across American contexts. Consider the roles of collectives, social movements, mutual aid, interdisciplinary thinking, power and social justice in addressing pathologies of power and working towards human well-being. Advocate a biosocial lens that considers the dynamic relationships between biology and environmental, social, geographic, and historical contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 3124

STS 3284 - Technology and Disability (3 credits)
Technologies and the experience of disability. The ways institutions, laws, and biases influence how disability is interpreted within engineering and design culture. How disability communities resist, negotiate, adopt, make, and change technologies. Development of work on this topic through making, doing, and writing. Conversations about ableism, media portrayals, historical narratives, ideology, and rhetoric surrounding technology and disability. Includes field trips to learn about the law and assistive technology.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3314 - Medical Dilemmas and Human Experience (3 credits)
Provides a humanist perspective on dilemmas of medical ethics. Focus on the varieties of human experience of medical dilemmas. Topics include contemporary controversies, such as assisted reproduction, genetic testing and treatment, clinical trials, end-of-life interventions, and the allocation of health-care resources.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3334 - Energy and Society (3 credits)
Examines the interconnections between energy use and social life. Considers the ways that modern social institutions, such as states, cities, and households are shaped by energy systems, particularly the pervasive use of fossil fuels. Explores the influence of energy extraction and commerce on economic development and global politics. Surveys major contemporary problems related to energy, including climate change and natural resource depletion. Develops an interdisciplinary framework, drawing insights from history, sociology, and economics, for evaluating policies to transition to a sustainable energy system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

STS 3705 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3705

STS 3706 - History of Science (3 credits)
Conceptual and institutional development of physical and biological sciences viewed within a cultural and societal context. 3705: Early Science; 3706: Modern Science
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3706

STS 3734 - History of Modern Biology (3 credits)
Exploration of the history of biology during the nineteenth century and twentieth centuries, including developments in evolutionary biology, genetics and molecular biology, biology and race, and conservation biology. Emphasis on biology's reciprocal relationship with society, how it has helped shape ideas of race and ethnicity, and the ethical dilemmas it has generated.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3734

STS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4014 - Algorithms & Society (3 credits)
This course focuses on social perspectives of algorithms and implications to factors such as class, gender, race, ethnicity, geography, and disability status. Students will be guided to think critically about the impacts of computing in society, as well as the role of social values in their design. Topics will focus on computing technologies involved in critical contemporary and global concerns including machine learning, privacy, and the infrastructure that describes the social and technical context for algorithms. Pre: Junior Standing
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4014

STS 4304 - Topics: Contemporary Issues in Science, Technology, and Society (3 credits)
Advanced introduction to social scientific concepts and methods in the study of contemporary science and technology. Examines the political, social, and cultural dimensions of a contemporary development or controversy in science and technology. Studies the relationship of science and technology to social structure, power relations, and inequality. Focuses on the institutions and organizations in which emergent science and technology are produced. Discusses policy options informed by social scientific analysis. May be repeated once with different content for a maximum of 6 credits. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

STS 4314 - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competencies, the use of narrative medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4314

STS 4314H - Narrative Medicine (3 credits)
Introduction to the field of narrative medicine, with attention to narrative competence, the use of narrative in medical education, and the function of narratives in the experience of healing. Includes narrative approaches to biomedical ethics.
Prerequisite(s): ENGL 3154 or ENGL 3324
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4314H

STS 4324 - Medical Experiences and Biomedical Theories (3 credits)
Builds the analytical tools of STS and humanistic deconstruction. Challenges students to read, write, and interrogate academic literatures and real-life, immediate problems and artifacts in ethical, sociocultural, historical, and context informed ways. Builds this competence while examining materials related to current topics in health, such as but not limited to: population, development, reproductive technologies, pollution, climate change, environmental health beyond humans, and, colonialism. Employs multiple humanistic lenses including: biopolitics & biopower, intersectionality, structural and institutional analysis, syndemics, anticolonialism, violence, and disability to examine these materials.
Prerequisite(s): STS 2154 or STS 3314 or SOC 3104
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4324

STS 4334 - Sexual Medicine (3 credits)
Discusses sex and medicine in contemporary U.S. society. Explores how notions of sexual behavior and normality are defined and structured by medical discourse. Examines cultural institutions that play significant roles in formulating ideas about and definitions of deviance, perversity, and tolerated marginality. Critiques medical responses to sexual variations. Examines experiences of people who have sought out, or been the unwilling victims of, sexual medicine. Junior standing required.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 4334

STS 4704 - Gender and Science (3 credits)
Investigates the gender dimensions of science in both historical and contemporary perspectives. Discusses feminist studies of science, exploring strengths and limitations. Assess implications of cultural assumptions about gender for practicing scientists. A 3000 level course in science or engineering may satisfy the prerequisite.
Prerequisite(s): STS 1504 or WGS 2244
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WGS 4704

STS 4754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

STS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Sociology

Our Website (http://www.sociology.vt.edu)

Overview

The Department of Sociology offers a B.S., M.S., and Ph.D. Sociology and is the home to two majors, sociology and criminology, and the Center for Peace Studies and Violence Prevention (CPSVP). Courses are open to students in all colleges of the university.

Sociology Major

In addition to fulfilling the requirements of the General Education (Pathways for students graduating in 2022 and beyond) sociology majors must complete 43 hours in sociology, including:

- 22 hours of sociology core courses and 21 hours of sociology electives, with no more than six hours at the 1000-2000 level,
- three hours at the 3000 level,
- at least nine hours at the 4000 level, and
- three hours in Africana Studies, American Indian Studies, or Women's and Gender Studies at the 2000, 3000, or 4000 level.

Criminology Major

In addition to fulfilling the requirements of the General Education (Pathways for students graduating in 2022 and beyond) criminology majors must complete 43 hours in criminology, including:

- 22 hours of sociology core courses,
- nine hours of required criminology courses, and
- 12 hours of elective criminology courses.

Minors

Minors in sociology must complete 18 hours in sociology including SOC 1004 Introductory Sociology. No more than nine hours at the 1000-2000 level will count toward a minor. A minimum GPA of 2.0 for courses in the minor is required. Sociology offers additional minors in Diversity and Community Engagement, Gender, Science and Technology, and Peace Studies and Social Justice. See the listing of the programs below for further information.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways) (see "Academics (p. 9)") and toward the degree in Sociology.

Satisfactory progress requirements toward the B.S. in Sociology can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

Center for Peace Studies and Violence Prevention

Director: James Hawdon

The Center for Peace Studies and Violence Prevention is a student-center, multi-disciplinary undertaking to promote research, education and outreach in the area of peace studies and violence prevention. Since its inception in 2008, the Center has adopted three thematic areas:

- The prevention of violence
- Peace studies
- The development of new leaders for this century

The Center is a hub for research and pedagogy on peace studies and violence prevention. Our multidisciplinary approach allows students, faculty, and a variety of off-campus constituents to address peace building and violence prevention in a holistic manner.

The Center for Peace Studies offers a minor in Peace Studies. The minor is designed to provide students with a broad perspective on violence prevention and peace building. Students minoring in Peace Studies will be required to take two core courses, PSVP 2044 Peace and Violence and PSVP 4104 Global Society, Violence and the Prospects for Peace. In addition, students will select four elective courses from a variety of courses that focus on either "local" issues of violence prevention and peace building or "global" issues of violence prevention and peace building.

- Criminology Major (p. 1163)
- Sociology Major (p. 1165)

Department Chair: Jennifer A. Johnson

Distinguished Professor: A. K. Harrison
Professors: O. Agozino, S. E. Bell, D. L. Brunsma, T. M. Calasanti, J. E. Hawdon, J. A. Johnson, N. M. King, L. Ritchie, B. Zare
Research Professor: D. A. Gill

Associate Professors: T. Dearden, M. Gardezi, S. Ovink, K. Parti, R. T. Perdue, P. Polanah, A. V. Reichelmann, J. M. Roos, D. Sedgwick, A. S. Vogt Yuan, D. Wimberley, H. Zhu
Associate Professor of Practice: S. Mehra
Assistant Professors: L. O'Donnell Goldensher, L. Halcomb, Z. Li, A. McCumber, H. Williams

Assistant Collegiate Professors: W. T. Jamerson, C. McCown

Adjunct Professors: R. Blieszner, D. Breslau, G. L. Downey, N. McGehee
Instructors: S. Choudhury, K. Dhillon-Jamerson, S. Diaz, S. Illahe, L. Simmons, J. Stilley, L. Weikart

Director of Undergraduate Studies: A. S. Vogt Yuan
Career Advisor: D. Sedgwick
Academic Advisors: R. Franklin, H. Hollandsworth
Distinguished Professor Emeritus: W. E. Snizek
Emeritus Professors: C. Bailey, C. Burger, E. Fuhrman, L. Gillman, M. Hughes, B. R. Hertel, K. J. Kiecolt, J. W. Michaels, W. Reed, S. Samanta, and D. R. Shoemaker

Undergraduate Course Descriptions (CRIM)

CRIM 1054 - Virginia Tech Prison Book Project (1 credit)
A one-hour course with the Virginia Tech Prison Book Project. Students will complete a learning module about carceral institutions in the United States and the impact of educational opportunities on the lives of incarcerated people. They will then participate in a service learning event where they match individual requests from incarcerated readers to books and prepare the books for shipping.
Instructional Contact Hours: (1 Lab, 1 Crd)
Course Crosslist: HUM 1054, RLCL 1054

CRIM 2504 - Crime and Punishment in American History (3 credits)
Analyzes changing understandings of crime and punishment from the Colonial Era to the Age of Mass Incarceration. Considers how factors of race, ethnicity, class, and gender intersected with changing ideas of criminality and punishments.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2504

CRIM 2754 - Internship (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2964 - Field Work/Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 3124 - Murder in American History (3 credits)
Considers how the definition of murder as a crime has changed from the colonial period to the present day. Uses murder cases to study the dynamics of American society in condemning, condoning, or celebrating murder. Asks how cultural factors, including racial prejudice, gender stereotypes, beliefs about sexuality, and class status affected the act of killing, media coverage of the event, societal reactions, and the execution of justice. Topics covered include abortion, lynching, vigilante justice, and the evolution of the legal system.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 3124

CRIM 3414 - Criminology (3 credits)
Principles of criminology and contemporary theories of criminal behavior, focusing on the extent and distribution of crime in the United States.
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 3434 - Systems of Justice (3 credits)
Analyzes the systems of justice in the United States, from a sociological perspective. Focuses on law enforcement, courts, and corrections. Evaluates the effectiveness of social policies related to systems of justice. Explores the structural, community, and individual level factors that influence different stages of justice systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 3474 - Women and Crime (3 credits)
Focuses on women as victims and perpetrators of crime, with particular attention to race and class. Analyzes how social, cultural, and economic factors influence victimization and participation in crime. Includes adolescent girls involvement with crime, including juvenile gangs. Evaluates theoretical explanations of why women commit crime. Examines womens experiences with the criminal justice system.
Prerequisite(s): CRIM 3414 or SOC 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4224 - Victimology (3 credits)
An in-depth exploration of the multifaceted field of victimology. A scientific study of victims and the aftermath of victimization, which delves into the physical, emotional, and psychological consequences victims endure. Provides insights into the historical context of victim studies, various theoretical frameworks, and the evolving role of the criminal justice system concerning victims' rights and advocacy. Additionally, this course examines the societal consequences of victimization and explores preventive, interventionist, and compensatory mechanisms to support victims and mitigate the impact of crimes.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4224

CRIM 4424 - Juvenile Delinquency (3 credits)
Examination of juvenile delinquency. Includes methods of data collection and the extent and distribution of delinquency. Detailed coverage of theories of delinquent behavior. Examines the juvenile justice system and treatment and prevention of delinquency. Utilizes current empirical research on delinquency in the U.S. and internationally.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4454 - Topics in Criminology (3 credits)
A variable topics course in criminology. In-depth examination of topics such as capital punishment, women and criminology, racial profiling, terrorism, white collar crime, law enforcement, international gangs, political crime, the prison system, cybercrime, and rape. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing.
Prerequisite(s): CRIM 3414 or SOC 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

CRIM 4474 - Cyber Criminology (3 credits)
Empirical patterns and consequences of cybercrimes. Emphasis on applying criminological theories of crime and victimization to cyberspace. Cybercrime prevention strategies and tactics. Examination of ethical issues of privacy, security, and social control. Pre: Junior standing.
Prerequisite(s): CRIM 3414 or SOC 3414
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4484 - Hate Crimes (3 credits)
Focuses on the causes, manifestations, and consequences of hate crimes in the United States. Includes theories of prejudice and biased behavior, the context of perpetration, the individual and community-level effects on the victims, and the political, historical, and social significance of such crimes. Considers broad questions of bias compared to hate, the recognition and prosecution of hate crimes compared to non-bias crimes, the impacts of hate crimes at the individual and community levels, and responses by law enforcement and communities.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4484

CRIM 4504 - Family and Crime (3 credits)
Focuses on the ways in which involvement in the criminal justice system affects families and family systems. Analyzes the antecedents and consequences of parental incarceration, including an investigation as to how social policies influence this phenomenon. Includes how offenders and their families are embedded in the criminal justice system and learn to navigate periods of incarceration and reentry—which includes family members' secondary prisonization. Examines the emotional and financial costs of incarceration and reentry on families, as families serve as informal safety nets.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)

CRIM 4754 - Internship (1-3 credits)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

CRIM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CRIM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (PSVP)

PSVP 2044 - Peace and Violence (3 credits)
Introduces major theories of peace and violence. Explores contemporary patterns and root causes of interpersonal, institutional, and structural violence. Particular attention to conflict management, prevention, strategies, and promotion of peace at the local, national, and global levels.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 2444 - Conflict Resolution, Mediation and Peacebuilding (3 credits)
Introduces fundamental principles, values and skills of conflict resolution. Special emphasis on facilitative mediation, restorative justice and other conflict resolution methodologies in the greater context of peacebuilding. Exploration of conflict resolution as tools of personal development and social justice.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4104 - Global Society, Violence and the Prospects for Peace (3 credits)
Examines major theories in the interdisciplinary field of peace studies. Includes current, historical, and global causes, patterns and types of conflict, and methods of conflict resolution. Particular attention given to the philosophical and sociological discussions of the causes of violence and the possibilities for peace.
Prerequisite(s): PSVP 2044 or SOC 2044
Instructional Contact Hours: (3 Lec, 3 Crd)

PSVP 4224 - Victimology (3 credits)
An in-depth exploration of the multifaceted field of victimology. A scientific study of victims and the aftermath of victimization, which delves into the physical, emotional, and psychological consequences victims endure. Provides insights into the historical context of victim studies, various theoretical frameworks, and the evolving role of the criminal justice system concerning victims' rights and advocacy. Additionally, this course examines the societal consequences of victimization and explores preventive, interventionist, and compensatory mechanisms to support victims and mitigate the impact of crimes.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 4224

PSVP 4444 - Schools, Violence, and Justice (3 credits)
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students rights/responsibilities.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4444

PSVP 4484 - Hate Crimes (3 credits)
Focuses on the causes, manifestations, and consequences of hate crimes in the United States. Includes theories of prejudice and biased behavior, the context of perpetration, the individual and community-level effects on the victims, and the political, historical, and social significance of such crimes. Considers broad questions of bias compared to hate, the recognition and prosecution of hate crimes compared to non-bias crimes, the impacts of hate crimes at the individual and community levels, and responses by law enforcement and communities.
Prerequisite(s): CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CRIM 4484

PSVP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSVP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (SOC)

SOC 1XXX3 - GEN ED REASONING SOCIAL SCI (3 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

SOC 1004 - Introductory Sociology (3 credits)
Principles and basic concepts of human interaction and social organization. Basic theories and research methods, socialization, deviance, social institutions, population dynamics, social change, and social inequality by social class, race/ethnicity, gender, and sexual orientation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 1014 - Introduction to Social Anthropology (3 credits)
Introduction to basic concepts including culture and ritual, research methods especially ethnography, and theory in social anthropology for understanding human behavior. Provides a survey of anthropological approaches to language, economics, kinship, religion, identity, gender, race, politics, social organizations, and globalization that compares western and non-western cultures.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 1024 - First Year Experience in Sociology (1 credit)
Develop an identity as a sociologist and foster a sense of community with first year and transfer students in the department. Acquire research skills and an awareness of university resources that enhance academic success. Explore theories used and topics examined by sociologists and participate in sociological research. Identify careers and internship opportunities in sociology.
Instructional Contact Hours: (1 Lec, 1 Crd)

SOC 1084 - Food Studies (3 credits)
Interdisciplinary introductory course explores how food shapes and is shaped by culture and society. Examines how people use food to express meanings (e.g., via foodways, story, art, architecture, religion, ethical codes), how food options, practices, and inequities are shaped by social structures (e.g. cultural and legal norms regarding race, class, and gender), and how the material properties of food (e.g., chemical, ecological, technological) are linked to identities, ideological commitments, and historical moments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 1084, PSCI 1084, RLCL 1084

SOC 2004 - Social Problems (3 credits)
Examines the nature, extent, and causes of social problems in the United States and around the globe from multiple perspectives. Emphasizes the role of social structural forces including conflicting economic, racial, ethnic, national, and gender interests in the creation and perpetuation of social problems. Discussion of poverty, work, health care, drugs, terrorism, human rights, and social change.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2014 - Sociology of Intimate Relationships (3 credits)
An introduction to concepts, theories, methods, and major research findings in the sociology of intimate relationships. A description and analysis of research findings on the development, operation, and dissolution of intimate relationships, including how sociocultural and economic changes have shaped intimate relationships over time. Emphasis on the United States, including issues of diversity and inequalities in intimate relationships.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2024 - Sociology of Race and Ethnicity (3 credits)
Social construction of race and ethnicity. Relations among ethnic and racial groups. Immigration and patterns of racial and ethnic integration. Social structures and processes that perpetuate racial and ethnic stratification. Consideration of economic, social, political, and health challenges facing racial/ethnic minority groups in U.S. society. Core Curriculum approved for CLE Area 2 only when taken only in combination with AFST 1714.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2034 - Diversity and Community Engagement (3 credits)
Examination of patterns, meanings, and challenges of diversity and inclusion to improve social interactions and community engagement within a global society. Focus on diverse identities, social justice, power, and privilege, applying social science theories and concepts, to facilitate intercultural awareness. Community engagement projects employ research methods to connect course materials and service to community.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2054 - Ethnography: Studying Culture (3 credits)
Introduction to the methodological tools used by anthropologists and other social scientists to study culture. Engagement with the development of, and debates about, ethnographic methods, as well as their application to case studies. Focus on sample ethnographic accounts of peoples throughout the world, as well as research techniques applicable to many different cultural environments.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2054

SOC 2104 - Quantitative Approaches to Community Research (3 credits)
Computational methods and ethical issues in the collection, transformation, consumption, and use of quantitative data in the design and evaluation of community programs. Consideration of effective data visualization and communication of findings. Emphasis on evaluating the reliability and accuracy of data used to frame decisions about community-related policies and service-oriented programs.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 2104

SOC 2264 - Race, Class, Gender, and Sexualities (3 credits)
Focuses on how race, class, gender, and sexualities form interlocking systems of privilege and oppression at individual and institutional levels. Emphasizes race, class, gender, and sexualities as changing social constructions and interactive systems that shape social institutions and organizations, meanings, and identities.
Prerequisite(s): WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2264, WGS 2264

SOC 2304 - Individual In Society (3 credits)
Foundation in social psychological principles of sociology including the development of the self through social interaction and intergroup processes. Factors affecting self-perceptions, ways of thinking, attitudes, emotions, behavior, and psychological well-being in social contexts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2404 - Deviant Behavior (3 credits)
Examines behaviors considered deviant in the United States. Explores major types of deviant behavior, such as corporate crimes, extremist groups, sexual deviance, violence, suicide, alcoholism and other drug addictions, and cyber deviance. Includes sociological theories that explain them.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2454 - Race and Racism (3 credits)
Examines theories of race and racism specifically as they relate to African Americans. We will explain conservative, neo-conservative, liberal, and progressive ideologies concerning race in past and recent United States contexts and how such theories emerged and continue to emerge in recent times. Though the majority of the course focuses on race and racism within the U.S comparative analyses will be made with Brazil and South Africa.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AFST 2454

SOC 2514 - Asian American Experience (3 credits)
Interdisciplinary overview of the diverse Asian American experience, incorporating non-Eurocentric perspectives on the Asian immigrant experience and dialogue between Asian American and non-Asian American students. Examination of different historical tracks of various Asian ethnicities, experience of racism, discrimination, cultural adaptation and conflict, and economic survival and success. Gender, age, religious affiliation, family values and inter-generational differences among Asian Americans. The complexity of minority status and the stereotype of "model minority." Activism, political participation, leadership and the meaning of citizenship among Asian Americans. Representations of Asian Americans in the arts and media.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 2514

SOC 2604 - Introduction to Data in Social Context (3 credits)
Examines the use of data to identify, reveal, explain, and interpret patterns of human behavior, identity, ethics, diversity, and interactions. Explores the historical trajectories of data to ask how societies have increasingly identified numerical measures as meaningful categories of knowledge, as well as the persistent challenges to assumptions about the universality of categories reducible to numerical measures.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 5F Quant & Comp Thnk Found., 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HIST 2604, STS 2604

SOC 2744 - Black Food in the US: Race, Racism, and Food Studies (3 credits)
A survey of the relationship between Black people in the United States with respect to food, culture, and society. Specifically covers Black food narratives, practices, space, place, as well as issues of inequality and exploitation within society.
Pathway Concept Area(s): 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 3004 - Social Inequality (3 credits)
Class, status, and power in society. Theories and empirical research findings on vertical and horizontal stratification in society. Class differences in behavior, values, and avenues and extent of social mobility. Cross cultural comparisons.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3014 - Gender Relations (3 credits)
Focus on the social construction of gender relations. Examines how gender relations vary cross-culturally, historically, and for different categories of men and women. Explores the causes and consequences of inequality and privilege. Attention paid to the ways race, ethnicity, class, age, and sexualities shape and are shaped by gender and the relationship of gender to social institutions.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3104 - Sociological Theory (3 credits)
Focus on the development and contemporary state of sociological theory. Primary concern is with those theorists who have had significant impact on our thinking about the relationships among man, society, and nature.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3144 - Language and Ethnicity in the United States (3 credits)
Exploration of how racial and ethnic identity are expressed through the use of different languages and dialects. Examination of how language is related to issues of equality, social opportunity, and discrimination in the United States.
Prerequisite(s): ENGL 1106 or ENGL 1204H or COMM 1016
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 3144, RLCL 3144

SOC 3204 - Social Research Methods (4 credits)
Techniques of data collection and analysis employed in the social sciences with emphasis on survey research methods including questionnaire construction, sampling, and analysis of both self-collected and national data; logic behind application of these techniques.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (4 Lec, 4 Crd)

SOC 3314 - Social Movements (3 credits)
The study of collective attempts to address social injustices and implement other social change in and across societies. Explores sociological and interdisciplinary conceptions of social movements and their relationships to society. Social movement emergence, development, engagement with opponents and authorities, and impact, as shaped by opportunity structures, mobilizing structures and processes, framing, collective identity, strategy and tactics, and other factors. How social movements oppose or promote inequality, oppression, or violence in the U.S. or elsewhere, at the local, national, and transnational level. Application of political process and other current social movement theories.
Prerequisite(s): SOC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3404 - Environmental Justice (3 credits)
Causes and consequences of environmental and climate injustices; interactions between social inequalities (race, gender, class, position in world-system) and environmental pollution, food and land injustice, climate injustice, and environmental health; environmental racism in environmental policies and practices; political-economic barriers to achieving environmental justice; evaluation of environmental justice reforms and sustainability initiatives; possibilities for system change; social movement strategies for achieving environmental and climate justice; case studies in environmental justice and injustice.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, GEOG 3464, HD 3464, HUM 3464, UAP 3464

SOC 3504 - Population Trends and Issues (3 credits)
Contemporary American and global population trends in historical and comparative perspective. Discussion of the impact of population change on individual and society. Relevant public policy questions examined.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3614 - Gender and Work in the U.S. (3 credits)
Examination of the role that gender plays in shaping the experience of work, focusing especially on the persistence of occupational segregation by sex, its causes and implications. Also, the interaction of work and family life, including the allocation of household work and control of resources. Social policies affecting gender relations in work organizations will be analyzed.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3714 - Sociology of Aging (3 credits)
Emergence of old age as a social problem. Social aspects of aging in America, including the minority experience and with some cross-cultural comparisons. Social and demographic characteristics of the aged, location of aged in the social structure, and current and future social problems of old age.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3854 - Globalization: Sociological Perspectives (3 credits)
Distinguishes global from international. Examines social globalization and cultural globalization and what forms they take. Explores changes in the role of nation-states and the implications of global changes in the division of labor for economic, gender, and racial/ethnic inequalities. Discusses how globalization is linked with peace, violence, and human rights. Considers alternative and more equitable forms of globalizations and how social movements might lead to such alternatives.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 3884 - Culture and Society in Contemporary Europe (3 credits)
The impact of religion and culture in contemporary European politics and societies. Nationalism versus European cosmopolitanism. Religion, religious radicalism and religious tolerance in Europe. Culture and society in European urban and rural areas. Attitudes towards women and LGBTQ in Europe. Social foundations and cultural determinants of marginalization of social groups, migrants and refugees.
Prerequisite(s): IS 1104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3884, RLCL 3884

SOC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4014 - Sociology of the Family (3 credits)
The family as a basic social institution: similarities and variations in family systems, their interrelationships with other social institutions, and patterns of continuity and change. Taught alternate years.
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4024 - Sociology of Religion (3 credits)
Religion as a social structure as well as an institution; with special attention to the functions of religion for individuals, groups and societies, social organization; and the interplay between religion and other social institutions including economics and polity. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: RLCL 4024

SOC 4034 - Sociology of Education (3 credits)
Analysis of the structure, functions, and consequences of schooling in America, the social processes affecting academic achievement, and the implications of current knowledge for educational reform. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4044 - Military Sociology (3 credits)
The military institution and its relationship to society. Emphasis on the role of the military and its social organization; recruitment, socialization, career, combat, deviant behavior, changes in the military, and future trends. Taught alternate years. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4054 - Appalachian Languages and Cultures (3 credits)
An empirical examination of how Appalachian speech both reflects and constitutes regional cultures. Emphasis is on applying sociological and anthropological methods and theories to the study of language in use.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4034

SOC 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4094, PHS 4094

SOC 4114 - The Sociology of Popular Music (3 credits)
Examine the social context(s) of popular music, including the social, economic, and political factors that influence the development of different popular music forms; authenticity within popular music genres; popular musics impact on social activity and identity; the institutions that connect popular music producers with consumers.
Prerequisite(s): SOC 1004 and SOC 1014 or AFST 1714
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4124 - Topics in Culture (3 credits)
Uses sociological, anthropological, as well as artistic and humanist paradigms to analyze culture. Discusses 20th and 21st century cultural trends. Analyzes the implications of social context for cultural artifacts such as art. Topics are variable. Example topics include the cultural construction of race and the cultural of the nineteen sixties. Course may be repeated with different course content for up to 6 credits. Pre: Junior or Senior standing.
Prerequisite(s): SOC 1004 or SOC 1014 or AFST 1714 or AINS 1104 or RLCL 1004 or RLCL 2004 or WGS 1824
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: HUM 4124

SOC 4194 - Senior Seminar (3 credits)
Required seminar for majors. Integration and application of prior coursework, including reviews of theory and research methods. Application of sociological knowledge toward an actual needs assessment in a work setting, completion of a social policy analysis, and a written critique of a sociological publication. Course serves as a bridge to graduate study, prepares students for application of sociological knowledge, and provides overall career guidance. Senior standing and sociology majors only.
Prerequisite(s): SOC 3104 and SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4204 - Applied Research (3 credits)
Stresses differences between applied research and other methodologies. Examines the topics, purposes, problems, theories, and methods appropriate for applied research. Explores ethical and political issues prevalent in applied settings. Includes qualitative, quantitative, and mixed methodologies. Emphasis on survey construction and administration, experimental designs, evaluation research, and participatory action research as used by applied researchers. Includes data analysis and issues of presenting applied research to lay audiences.
Prerequisite(s): SOC 3204 and STAT 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4294 - Capstone: Diversity Engagement (3 credits)
In-depth examination of core themes of diversity. Explains patterns and relational/intersectional aspects of diversity, including the history and legacies of inclusion and exclusion, from a variety of perspectives. Synthesizes diverse writings on issues of social justice and community, power and privilege. Uses social science theories and concepts of diversity to examine contemporary issues of diversity and to facilitate and interpret community engagement projects based in students major fields of study. Focuses on collective responsibility to eliminate bias and discrimination through students community-based project outcomes. This course is restricted to students who have enrolled in the Diversity and Community Engagement Minor.
Prerequisite(s): SOC 2034
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4304 - Research Methods Topics (3 credits)
Variable topics course that focuses on different research methodologies. Includes topics such as feminist research, qualitative methodologies, survey design, evaluation research, and anthropological methods. Can be taken multiple times if different topic.
Prerequisite(s): SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 99 credit hours

SOC 4324 - Medical Experiences and Biomedical Theories (3 credits)
Builds the analytical tools of STS and humanistic deconstruction. Challenges students to read, write, and interrogate academic literatures and real-life, immediate problems and artifacts in ethical, sociocultural, historical, and context informed ways. Builds this competence while examining materials related to current topics in health, such as but not limited to: population, development, reproductive technologies, pollution, climate change, environmental health beyond humans, and, colonialism. Employs multiple humanistic lenses including: biopolitics & biopower, intersectionality, structural and institutional analysis, syndemics, anticolonialism, violence, and disability to examine these materials.
Prerequisite(s): STS 2154 or STS 3314 or SOC 3104
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STS 4324

SOC 4404 - Sociology of Law (3 credits)
The functions of law as a form of social control. The social forces in the creation, enforcement, and change of the law. The nature of law as a force in social change. Taught alternate years.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4414 - Drugs and Society (3 credits)
Examines the use of drugs, including legal and illegal drugs, from a sociological perspective. Cross-cultural and historical patterns of use are discussed and explained. Particular attention is given to drug use within the context of various social institutions. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4444 - Schools, Violence, and Justice (3 credits)
Focuses on the nature, extent, causes, and consequences of widely recognized forms of violence within schools, such as bullying, fighting, sexual assaults, harassment, dating violence, and shootings. Examines the effectiveness of violence prevention programs. Includes sociological theories of violence within schools. Explores the social debate over balancing the collective public safety obligations of schools with individual students rights/responsibilities.
Prerequisite(s): SOC 3414 or CRIM 3414
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PSVP 4444

SOC 4454 - Topics in Sociology (3 credits)
A variable topics course in sociology. In-depth examination of topics such as environmental sociology, the sociology of sport and competition, social networks, and sociology of the body. May be repeated 2 times with different content for a maximum of 9 credits. Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

SOC 4704 - Medical Sociology (3 credits)
Social and cultural response to illness and infirmity. Emphasis on the sick role, patient role, practitioner role, organization and politics of health care delivery, stratification, professionalism, and socialization of health practitioners. Taught alternate years. Junior Standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4714 - Sociology of Mental Illness (3 credits)
Mental illness and social systems, historically and in contemporary society. Distribution of mental illness with special reference to stratification, role, and deviance theories. Mental health occupations and organization of treatment. Implications for social policy. Taught alternate years. Junior standing.
Prerequisite(s): SOC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

SOC 4754 - Internship (1-3 credits)
Placement and sociologically relevant work in one of a variety of human service settings, combined with relevant readings, discussion and written work coordinated jointly by a faculty member and the setting supervisor. Placement settings include human resource agencies, corrections facilities, extension offices, and law agencies. Sociology major or minor required. Junior or Senior standing required. Consent of internship coordinator required. Coursework relevant to placement setting.
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

SOC 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4764, UAP 4764

SOC 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SOC 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Criminology Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements [1]		
Sociology		
Take in the order listed		
SOC 1004	Introductory Sociology	3

SOC/HD 2104	Quantitative Approaches to Community Research	3
or STAT 3604	Statistics for Social Science	
SOC 3104	Sociological Theory [2]	3
SOC 3204	Social Research Methods	4
SOC 3004	Social Inequality	3
SOC 4194	Senior Seminar	3
Africana Studies, American Indian Studies and Women's and Gender Studies Elective Courses		
Select one of the following:		3
AFST 1714	Introduction to African American Studies	
AINS 1104	Introduction to American Indian Studies	
WGS 1824	Introduction to Womens and Gender Studies	
Subtotal		22
Major Requirements		
Take in order listed		
SOC 2404	Deviant Behavior	3
CRIM 3414	Criminology	3
CRIM 3434	Systems of Justice	3
Subtotal		9
Elective Courses		
Select 12 credits of the following: [3]		12
CRIM/HIST 2504	Crime and Punishment in American History	
CRIM/HIST 3124	Murder in American History	
CRIM 3474	Women and Crime	
CRIM 4424	Juvenile Delinquency	
CRIM 4454	Topics in Criminology [4]	
CRIM 4474	Cyber Criminology	
CRIM 4484	Hate Crimes	
CRIM 4504	Family and Crime	
CRIM 4754	Internship	
CRIM 4974	Independent Study (in a related area with approval of the department chair)	
CRIM 4994	Undergraduate Research (in a related area with approval of the department chair)	
PSVP 2044	Peace and Violence	
PSVP 2444	Conflict Resolution, Mediation and Peacebuilding	
PSVP 4444	Schools, Violence, and Justice	
SOC 4404	Sociology of Law	
SOC 4414	Drugs and Society	
Subtotal		12
Free Electives		
Select 32 credits		32
Subtotal		32
Pathways to General Education		
All students must fulfill the requirements of the Pathways for General Education Curriculum. Check the Undergraduate Course Catalog & Academic Policies for prerequisites		
Pathways Concept 1 - Discourse		
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select six hours in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways to General Education Curriculum).
2. It is recommended to take two of the following courses prior to registering for SOC 3104: SOC 2004 Social Problems, SOC 2014 Sociology of Intimate Relationships, SOC 2024 Sociology of Race and Ethnicity, SOC 2034 Diversity and Community Engagement, SOC 2304 Individual In Society, and/or SOC 2404 Deviant Behavior.
3. A maximum of 3 credits from CRIM 4754, CRIM 4974, and CRIM 4994 can be used to fulfill the requirements of the major.
4. CRIM 4454 Topics in Criminology may be taken up to three times; topics must be different.

Requirements for Satisfactory Progress: Students must have completed SOC 1004 Introductory Sociology, SOC 3104 Sociological Theory, SOC 3204 Social Research Methods, and an additional 6 credits of required or elective courses for the criminology major prior to attempting 72 credits (including transfer, advanced placement, advanced standing, and credit by examination).

Upon having attempted 60 credits, students must have an in-major GPA of 2.0 and an in-major GPA of 2.0 thereafter to be considered as making satisfactory progress toward the degree.

If satisfactory progress is not made, procedures will be followed as required by the Academic Eligibility Policy.

Graduation Requirements

Number of Credits for a Bachelor of Science Degree: 120 credits.

77 credits must be completed beyond what is required for a major in criminology.

Number of Credits for a Criminology Major: 43 credits.
The 43 credits consist of 22 credits of sociology core degree courses and 21 credits of additional courses for a criminology major.

Number of Credits of Free Electives: 32 credits.

Number of Credits for the Pathways General Education Curriculum: 45 credits.
All students with a criminology major are required to complete the Pathways General Education Curriculum.

Double Majors in the Department of Sociology: The Department of Sociology offers a major in sociology, with and without options, and a major in criminology. Students are permitted to obtain both majors. Courses in the sociology core degree can meet the requirements of both majors, but none of the other required or elective courses taken for either major can count toward the other.

Minimum GPA: A minimum 2.0 in-major GPA and 2.0 overall GPA.
All courses with a SOC prefix, CRIM prefix, or cross-listed with SOC and/or CRIM are included in the calculation of the in-major GPA.

Grade Requirement: Courses taken as part of the sociology core degree and criminology major must be taken for a letter grade of A-F.

Prerequisites: Check the Undergraduate Course Catalog & Academic Policies for prerequisites.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

Sociology Major

Requirements for Satisfactory Progress: Students must have completed SOC 1004 Introductory Sociology, SOC 3104 Sociological Theory, SOC 3204 Social Research Methods, and an additional 9 credits of sociology courses prior to attempting 72 credits (including transfer, advanced placement, advanced standing, and credit by examination).

Upon having attempted 60 credits, students must have an in-major GPA of 2.0 and an in-major GPA of 2.0 thereafter to be considered as making satisfactory progress toward the degree.

If satisfactory progress is not made, procedures will be followed as required by the Academic Eligibility Policy.

Graduation Requirements

Number of Credits for a Bachelor of Science Degree: 120 credits.
77 credits must be completed beyond what is required for a major in sociology.

Number of Credits for a Sociology Major: 43 credits.
The 43 credits consist of 22 credits of sociology core degree courses.

Number of Credits of Free Electives: 36 credits.

Number of Credits for the Pathways to General Education Curriculum: 45 credits.

Double Majors in the Department of Sociology: The Department of Sociology offers a major in sociology, with and without options, and a major in criminology. Students are permitted to obtain both majors. Courses in the sociology core degree can meet the requirements of both majors, but none of the other required or elective courses taken for either major can count toward the other.

Minimum GPA: A minimum 2.0 in-major GPA and 2.0 overall GPA.
All courses with a SOC prefix or cross-listed with SOC are included in the calculation of the in-major GPA.

Grade Requirement: Courses taken as part of the sociology major must be taken for a letter grade of A-F.

Prerequisites: Check the Undergraduate Course Catalog & Academic Policies for prerequisites.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

Code	Title	Credits
Degree Core Requirements [1]		
Sociology		
Take in the order listed		
SOC 1004	Introductory Sociology	3
SOC/HD 2104	Quantitative Approaches to Community Research	3
or STAT 3604	Statistics for Social Science	
SOC 3104	Sociological Theory [2]	3
SOC 3204	Social Research Methods	4
SOC 3004	Social Inequality	3
SOC 4194	Senior Seminar	3
Africana Studies, American Indian Studies and Women's and Gender Studies Elective Courses		
Select one of the following:		3
AFST 1714	Introduction to African American Studies	
AINS 1104	Introduction to American Indian Studies	
WGS 1824	Introduction to Womens and Gender Studies	
Subtotal		22
Sociology Elective Courses		
Select from the following:		18
A course cross-listed with Sociology used to fulfill this requirement cannot also be used to fulfill other requirements of the major. Courses **must** have SOC department heading in order to count towards major (ex: SOC 1234). Check the Undergraduate Course Catalog & Academic Policies for prerequisites.		
1000-2000 level: Must take 6 credits with 6 credits maximum. [3]		
3000 level: 3 credits required; may take 3 credits of 4000 level instead. Maximum of 3 credits.		

4000 level: Minimum of 9 credits. [4]		
Subtotal		18
Africana Studies, American Indian Studies, and Women's and Gender Studies Elective Courses		
Any 2000-4000 level AFST, AINS, or WGS course can be used to fulfill this requirement. [5]		3
Subtotal		3
Free Electives		
Select 32 credits		32
Subtotal		32
Pathways to General Education [6]		
All students must fulfill the requirements of the Pathways to General Education Curriculum. Check the Undergraduate Course Catalog & Academic Policies for prerequisites		
Pathways Concept 1 - Discourse		
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six hours in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Select six hours in in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		6
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways to General Education Curriculum).
2. It is recommended to take two of the following courses prior to registering for SOC 3104 Sociological Theory: SOC 2004 Social Problems, SOC 2014 Sociology of Intimate Relationships, SOC 2024 Sociology of Race and Ethnicity, SOC 2034 Diversity and Community Engagement, SOC 2304 Individual In Society, and/or SOC 2404 Deviant Behavior.
3. A maximum of 3 credits from SOC 2754 , SOC 2964 Field Study, and SOC 2974 Independent Study can be used to fulfill the requirements of the major.
4. A maximum of 3 credits from SOC 4754 Internship, SOC 4964 Field Study, and SOC 4974 Independent Study can be used to fulfill the requirements of the major.
5. A course cross-listed with sociology used to fulfill the 3 credit 2000-4000 level AFST, AINS, or WGS course elective cannot also be used to fulfill other requirements of the major.
6. All pathways courses must be at least 3 credit hours per course. All students must fulfill the requirements of the Pathways to General Education Curriculum.

Natural Resources and Environment

Our Website (http://www.cnre.vt.edu)

Overview

The College of Natural Resources and Environment (https://cnre.vt.edu/), through offerings in the Departments of Fish and Wildlife Conservation, Forest Resources and Environmental Conservation, Geography, and Sustainable Biomaterials, provides an integrated education in renewable natural resource management, conservation, and utilization, as well as a valuable perspective for understanding and solving critical contemporary environmental problems at local, regional, and global scales.

All undergraduate programs of the College of Natural Resources and Environment are designed to provide a professional education that starts with core courses emphasizing physical, biological, and social sciences, along with concepts of renewable natural resource management and sustainability. More advanced courses teach the principles and practices of individual disciplines, along with advanced skills in communications, data analysis and interpretation, and computer modeling. Students prepare for professional careers with public agencies responsible for predicting the weather and managing forest, water, wildlife, fish, and recreation resources; with private firms concerned with producing, manufacturing, and marketing packaging and wood products; with planning agencies and private firms utilizing skills in environmental and land-use analysis and geospatial techniques; or for graduate studies.

Students may develop additional depth of knowledge and specialized skills through completion of options within a major and completion of a minor. Majors offered within the college and options for further specialization are provided below:

Department of Fish and Wildlife Conservation

- Fish Conservation with options:
  - Freshwater Fisheries Conservation
  - Human Dimensions
  - Marine Fisheries Conservation
- Wildlife Conservation with options:
  - No option
  - Human Dimensions

Department of Forest Resources and Environmental Conservation

- Environmental Conservation and Society
- Environmental Data Science
- Environmental Resources Management

- Forestry
- Water: Resources, Policy, and Management

Department of Geography

- Geography
- Meteorology

Department of Sustainable Biomaterials

- Packaging Systems and Design
- Sustainable Biomaterials

The college offers minors (https://cnre.vt.edu/academics/degrees-majors/minors.html) in Forestry, Geographic Information Science, Geography, Meteorology, Natural Resource Recreation, Packaging Systems and Design, Sustainable Biomaterials, Urban and Community Forestry, Watershed Management, and Wildland Fire Ecology. The college offers Pathways minors in Biodiversity Conservation, Blue Planet, Climate and Society, Ecological Cities, and Pathways to Sustainability. Contact the respective departments for more information on minors.

Accreditation

The educational programs in Forestry qualify graduates as professional foresters and are accredited by the Society of American Foresters, the recognized accrediting body. Graduates in Fish and Wildlife Conservation meet certification requirements of the American Fisheries Society and The Wildlife Society, respectively. The Sustainable Biomaterials major is accredited by the Society of Wood Science and Technology, the recognized accrediting body. The degree in Meteorology was developed from guidelines recommended by the American Meteorological Society and the National Weather Service; the degree meets requirements of the federal civil service (GS-1340) for a meteorologist.

Honors College

The University Honors Program is available to students in the College of Natural Resources and Environment. The program provides enriched opportunities for highly qualified and motivated undergraduate students.

Cooperative Education

The college encourages students to become involved in the undergraduate Cooperative Education Program, in which students alternate on-campus academic terms with off-campus employment in their areas of interest.

Study Abroad and Exchange Programs

The College of Natural Resources and Environment offers numerous opportunities to study abroad and earn credits toward degree completion in locations such as Antarctica, Australia, Botswana, Galápagos Islands, Ireland, New Zealand, Panama, and other locations throughout the world. The college participates in reciprocal exchange programs with the University of Canterbury in Christchurch, New Zealand. Where appropriate, students can also participate in the International Student Exchange Program.

Graduate Programs

The college offers educational programs leading to the M.S., M.F., M.N.R, and Ph.D. Complete information on these programs is in the Graduate Catalog.

- Environmental Conservation & Society Major (p. 1186)
- Environmental Data Science Major (p. 1189)
- Environmental Resources Management Major (p. 1191)
- Fish Conservation Major with Freshwater Fisheries Conservation Option (p. 1170)
- Fish Conservation Major with Human Dimensions Option (p. 1172)
- Fish Conservation Major with Marine Fisheries Conservation Option (p. 1174)
- Forestry Major (p. 1193)
- Geography Major (p. 1206)
- Meteorology Major (p. 1208)
- Packaging Systems and Design Major (p. 1215)
- Sustainable Biomaterials Major (p. 1216)
- Water: Resources, Policy, and Management Major (p. 1195)
- Wildlife Conservation Major (p. 1175)
- Wildlife Conservation Major with Human Dimensions Option (p. 1177)

Dean: Paul M. Winistorfer
Associate Dean: Keith W. Goyne
Associate Dean for Extension, Outreach, and Engagement: Brian Bond
Assistant Dean of Advancement: Andrew Ickes
Assistant Dean of Business, Finance, and Administration: Candice Albert
Director of Academic Advising: Stephanie Hart
Director of Inclusion and Diversity: Maryam Kamran
Director of Employer Relations: John Freeborn
Director of Recruitment: John Gray Williams

Fish and Wildlife Conservation

Our Website (http://www.fishwild.vt.edu)

Fish Conservation

The Fish Conservation program is for students interested in research and management of aquatic animals and ecosystems, including wild fish and shellfish, endangered species, and hatchery-raised fish. Most graduates work for state or federal fisheries agencies, environmental consulting firms, or public utilities. Because the more challenging and rewarding jobs require a master's degree, the program emphasizes preparation for graduate study.

Wildlife Conservation

The Wildlife Conservation program is for students interested in research and management of terrestrial animals and ecosystems, including game birds and mammals, non-game animals, and endangered species. Most graduates work for state or federal wildlife agencies, environmental consulting firms, or private land management companies. Because the more challenging and rewarding jobs require a master's degree, the program emphasizes preparation for graduate study.

- Fish Conservation Major with Freshwater Fisheries Conservation Option (p. 1170)
- Fish Conservation Major with Human Dimensions Option (p. 1172)
- Fish Conservation Major with Marine Fisheries Conservation Option (p. 1174)
- Wildlife Conservation Major (p. 1175)

- Wildlife Conservation Major with Human Dimensions Option (p. 1177)

Head: Joel W. Snodgrass
Professors: P. L. Angermeier, K. A. Alexander, C. A. Dolloff, J. D. Fraser, E. A. Frimpong, C. A. Haas, E. M. Hallerman, W. A. Hopkins, Y. Jiao, S. M. Karpanty, M. J. Kelly, D. J. Orth, and D. F. Stauffer
Associate Professors: L. J. Castello, J. M. Ford, J. W. Jones, and J. A. Parkhurst
Assistant Professors: M. Cherry, A. Dayer, L. Escobar, Francesco Ferretti, and Holly Kindsvater
Adjunct Professors: B. Czech, P. Grobler, M. Joos Vandewalle, D. Hawley, T. J. Newcomb, E. Smith, H. Schwarz, J. Walters, and Y. Palti
Career Advisors: *Fish Conservation Undergraduate* - E. M. Murphy (231-6959), *Wildlife Conservation Undergraduate* - C. A. Haas (231-9269)

Undergraduate Course Descriptions (FIW)

FIW 2114 - Principles of Fish and Wildlife Conservation (3 credits)
Basic principles, key people, agencies and laws guiding the science-based conservation and management of fish and terrestrial animals. Conservation and management of organisms, habitats, and human users examined in terms of biological, physical, ecological, ethical and sociological theories and practices. Local to global illustration from both recreational and commercial resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2234 - Fish, Fishing, and Conservation (3 credits)
Sensory perception, behavior, and consciousness in fish. Principles, as related to fish and why they matter, fish conservation ethics, food security, recreational fishing, and responsible fishing practices. Ethical reasoning applied to the contemporary issues of conservation and use of fish, such as subsistence fishing, fish farming, marine protected areas, highly migratory fishes, sharks tourism, and ornamental fishes.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2314 - Wildlife Biology (3 credits)
Summary of biological characteristics of wild birds and mammals, especially relating to management by humans. Physiological, functional, structural, and behavioral adaptations of individuals to their environments and foods.
Prerequisite(s): (BIOL 1105 or BIOL 1205H) and (BIOL 1106 or BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2324 - Wildlife Field Biology (3 credits)
Systematics, identification, and natural history of common native vertebrates and plants. Exposure to habitats/ecosystems of western Virginia. Observation, collection, and reporting of field data. Self-scheduled field and media lab activities required.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FIW 2334 - Urbanization and Biodiversity Conservation (3 credits)
Overview of challenges and opportunities that urban environments create for biodiversity conservation and human wellbeing, with a focus on social sciences theories and approaches. How urbanization is changing people's relationship with their environment and what that means for biodiversity conservation and human wellbeing. Examination of how data collection, analysis, and interpretation occur using social sciences methods applied to biodiversity conservation. Diversity, Equity, and Inclusion in the context of urbanization and conservation.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 2334

FIW 2514 - Fish and Wildlife Conservation Policy (3 credits)
Foundations of U.S. and Virginia fish and wildlife conservation policy (FWC), including international agreements. Ethical, religious, and legal foundations of FWC policy. Roles of values and beliefs in conservation behavior. Constitutional basis for FWC policy in the U.S. How FWC policies are made, implemented, and revised through state and federal agencies. Major conservation policy strategies, particularly the value of stakeholder collaboration for successful policy development, passage, and implementation. Conduct independent and group social science research to identify and present compelling policy solutions for an FWC problem.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 3514 - Fisheries Techniques (3 credits)
Application of field and laboratory methods in fisheries management and research. Experience with fisheries equipment and techniques.
Prerequisite(s): FIW 2114 and STAT 3615
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FIW 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 3954C - Study Abroad (1-19 credits)
Pathway Concept Area(s): 3 Reasoning in Social Sciences
Instructional Contact Hours: Variable credit course

FIW 3954D - Study Abroad (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

FIW 3964 - Internship Through Directed Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

FIW 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4114 - Biodiversity Conservation (3 credits)
Advanced concepts and practices related to the conservation and enhancement of biological diversity. Understanding and analysis of causes of biological scarcity. Designing actions to mitigate biodiversity loss. Integration of legal, economic, social, and biological principles to develop solutions to conservation of organisms, populations and ecosystems. Cannot be taken for credit by Wildlife Conservation (WLC) majors.
Prerequisite(s): FIW 2114
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4214 - Wildlife Field Techniques (3 credits)
Field research methods for wild vertebrates in terrestrial environments. Application of research methodology including animal capture and marking, determination of sex, age, and condition, radio telemetry and map/compass/GPS orienteering, non-invasive methods of capture, habitat selection, and supervised group research projects. COURSE FEE $299.
Prerequisite(s): FIW 4414 and STAT 3615
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FIW 4244 - Applied Epidemiology of Fish and Wildlife Diseases (3 credits)
Theory and data analyses from veterinary epidemiology applied to fish and wildlife management. Biological sampling methods and data collection in fish and wildlife for epidemiological surveillance in free-ranging populations. Fish and wildlife epidemiology concepts, methods and applications for private, non-profit, academic, state, and federal agencies. Ethically measure, characterize, and forecast epidemics in fish and wildlife.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4314 - Conservation of Biological Diversity (4 credits)
Principles and practices of conserving biological diversity. Causes, consequences and rates of extinction. Application of philosophical, biological, sociological and legal principles to the conservation of genes, plant and animal species and ecosystems.
Prerequisite(s): FIW 4414 and FIW 4434
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4324 - Genetics of Natural and Mangaged Populations (3 credits)
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology.
Prerequisite(s): BIOL 1105 and BIOL 1106 and (STAT 3005 or STAT 3615 or FREC 3214)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4324

FIW 4334 - Mammalogy (4 credits)
Biology of mammals, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography.
Prerequisite(s): BIOL 2704 or BIOL 2704H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4344 - Herpetology (4 credits)
Biology of amphibians and reptiles, including evolution, systematics, anatomy, physiology, ecology, and conservation challenges. Laboratory focus on identification, morphology, and zoogeography.
Prerequisite(s): BIOL 2704 or BIOL 2704H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4414 - Population Dynamics and Estimation (3 credits)
Population growth, structure, and regulation of fish and wildlife populations including harvested populations, non-harvested populations, and small or declining populations. Methods of estimating demographic parameters such as population size, survival, and recruitment. Population viability analysis and genetic considerations in population dynamics.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4424 - Ichthyology (4 credits)
Morphology and physiology, systematics, zoogeography, and identification of fishes.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

FIW 4434 - Wildlife Habitat Ecology and Management (3 credits)
Relationship of wildlife species to their habitats. Factors influencing distribution and abundance of wildlife populations. Vegetation succession and structure, habitat classification, modeling wildlife habitat relationships and management of habitats in forests, agricultural lands, rangelands, riparian/wetland and urban areas.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4454 - Human-Wildlife Conflicts (3 credits)
Current and emerging human-wildlife interactions that lead to conflict; application of knowledge of animal behavior and life history, population dynamics, human dimensions, and ecosystem functions to analyze conflicts and formulate effective resolution; legal statutes and regulatory constraints on resolution; reliance on case studies of existing conflict situations to gain applied experience in diagnosing and solving human-wildlife conflicts using Vertebrate Integrated Pest Management protocols. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4464 - Human Dimensions of Fisheries and Wildlife (3 credits)
Values, attitudes, and opinions of people toward fish and wildlife. Social, economic, legal, and political aspects of fisheries and wildlife management. Roles of professionals and the public in fish and wildlife policy processes. Contemporary fish and wildlife policy issues. Senior standing required.
Prerequisite(s): FIW 2114
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4474 - Wildlife Habitat Evaluation (1 credit)
Methods to evaluate habitat quality for selected wildlife species. Determining habitat characteristics important to a selected species. Developing a habitat assessment approach to estimate habitat quality. Measuring and quantifying habitat characteristics. Assessing effects of management actions and habitat alterations on a selected wildlife species. Applying habitat assessment models to guide management and mitigation decisions. Techniques for oral and written presentations. Restricted to Wildlife Conservation Majors.
Corequisite(s): FIW 4434
Instructional Contact Hours: (3 Lab, 1 Crd)

FIW 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4354 or BIOL 4004 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: BIOL 4484, ENT 4484

FIW 4534 - Ecology and Management of Wetland Systems (3 credits)
Introduction to the variety of wetland systems found in North America, though emphasis will focus on eastern and mid-Atlantic wetland systems. Origin and processes of formation of wetlands, functions and values of wetlands, wetland delineation, wetland classification, regulatory processes affecting wetlands. Objectives of and management techniques used to protect and/or manipulate wetland systems for wildlife and other human needs. Enrollment restricted to junior, seniors and graduate students.
Prerequisite(s): BIOL 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FIW 4614 - Fish Ecology (3 credits)
Interactions of fish with the physical and biological environment. Adaptations of organisms, populations, and communities. Impacts of human activities on major aquatic ecosystems and important fishes. Ecological principles for management of important sport, commercial, and prey fishes.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4624 - Marine Ecology (3 credits)
Marine organism, biological, ecological, chemical and physical processes of marine ecosystems in open sea, coastal and benthic environments, research methods and models in marine ecosystem simulation; fisheries in a dynamic ecosystem: human interference and conservation.
Instructional Contact Hours: (3 Lec, 3 Crd)

FIW 4714 - Fisheries Management (4 credits)
History, theory, and practice of fisheries management. Emphasis on basic strategies used in effective management and setting management objectives. Synthesis of fish population dynamics and manipulation, habitat improvement, and human management to achieve objectives. Case studies of major fisheries.
Prerequisite(s): FIW 3514
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

FIW 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FIW 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Fish Conservation Major with Freshwater Fisheries Conservation Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2704	Evolutionary Biology	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FIW 4314	Conservation of Biological Diversity	4
or FIW 4714	Fisheries Management	
FIW 4414	Population Dynamics and Estimation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
NR 1234	First Year Experience In Natural Resources and Environment	3
or NR 2234	1st Semester Experience-Transfer Students in Natural Resources and Environment	
Subtotal		21
Major Requirements		
BIOL 2804	Ecology	3
FIW 3514	Fisheries Techniques	3
FIW 4424	Ichthyology	4
FIW 4614	Fish Ecology	3
Geographic Information Systems Restricted Elective		
Select one of the following:		3
FREC 4114	Information Technologies for Natural Resource Management	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
GEOG 2084	Principles of Geographic Information Systems	
GEOG/GEOS 4354	Introduction to Remote Sensing	
GEOS 3034	Oceanography	3
Subtotal		19
Additional Degree Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Experiential Learning Requirement		
Select one of the following: (requires department approval)		1
FIW 2974	Independent Study	
FIW 2994	Undergraduate Research	
FIW 3964	Internship Through Directed Field Study	
FIW 4974	Independent Study	
FIW 4994	Undergraduate Research	
XXXX 3954	(Study Abroad)	
Legal Foundation Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	

FIW 2514	Fish and Wildlife Conservation Policy	
FREC 4434	Natural Resource Policy	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Writing Restricted Elective		
Select one of the following:		3
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Subtotal		15
Option Required Courses		
FIW/FREC 4324	Genetics of Natural and Mangaged Populations	3
STAT 3616	Biological Statistics	3
Physical Science Restricted Elective		
Select one of the following:		3
ENSC 3134	Soils in the Landscape	
GEOS 1004	Earth Science: Our Past, Present, and Future	
GEOS 1024	Earth Resources, Society, and Environment	
PHYS 2205	General Physics	
PHYS 2206	General Physics	
Aquatic Ecology Restricted Elective		
Select two of the following:		8
FIW 4484	Freshwater Biomonitoring	
BIOL 4004	Freshwater Ecology	
BIOL 4454	Invertebrate Zoology	
ENT 4354	Aquatic Entomology	
Subtotal		17
Free Electives		
Select 3-4 credits		3-4
Subtotal		3-4
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3634	Communicating Ag and Life Sciences in Speaking (1A)	3
or COMM 2004	Public Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select one of the following:		3
FREC/LAR/NR 2554	Leadership for Global Sustainability	
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Select one of the following:		3
AAEC 1005	Economics of the Food and Fiber System	
or AAEC 1006	Economics of the Food and Fiber System	
ECON 2005	Principles of Economics	
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6
MATH 1025	Elementary Calculus (5F)	
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

1. By the end of the semester in which they have attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), students must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, and FIW 2114.

Graduation Requirements

1. **Major Requirements:**
   To earn a B.S. degree in Fish Conservation, a student must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, and FIW 2114.

   There are no hidden prerequisites on this check sheet; however, course requirements may change over time, and students should always check for prerequisites for classes they select.

   Students should consult www.fishwild.vt.edu/experiential_learning.html (http://www.fishwild.vt.edu/experiential_learning.html) for more details on how to fulfill the experiential learning requirement. Note that you will not receive credit for your experiential learning until **all** the documents related to the experience are completed and submitted, in addition to being registered for the experience. Students enrolling in FIW 2974, FIW 3964, or FIW 4974 should use the P/F option; FIW 2994, FIW 4994 and XXXX 3954 may be taken P/F or A/F.

   To remain in good standing, a student must achieve and maintain an overall and in-major cumulative GPA of at least 2.0. Courses used for the in-major GPA computation include all those designated as FIW, FREC, GEOG, NR, and SBIO. To graduate, a student must achieve an overall and in-major cumulative GPA of at least 2.0.
2. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways).

Foreign Language Requirement

Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation.

Fish Conservation Major with Human Dimensions Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2704	Evolutionary Biology	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FIW 4414	Population Dynamics and Estimation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
Select one of the following:		
NR 1234	First Year Experience In Natural Resources and Environment	2-3
or NR 2234	1st Semester Experience-Transfer Students in Natural Resources and Environment	
Select one of the following:		4
FIW 4314	Conservation of Biological Diversity (Wildlife Majors)	
or FIW 4714	Fisheries Management	
Subtotal		20-21
Major Requirements		
BIOL 2804	Ecology	3
FIW 3514	Fisheries Techniques	3
FIW 4424	Ichthyology	4
FIW 4614	Fish Ecology	3
Geographic Information Systems Restricted Elective		
Select one of the following:		3
FREC 4114	Information Technologies for Natural Resource Management	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
GEOG 2084	Principles of Geographic Information Systems	
GEOG 4354	Introduction to Remote Sensing	
GEOS 3034	Oceanography	3
Subtotal		19
Additional Degree Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Experiential Learning Requirement		
Select one of the following: (requires department approval)		1
FIW 2974	Independent Study	
FIW 2994	Undergraduate Research	
FIW 3964	Internship Through Directed Field Study	
FIW 4974	Independent Study	
FIW 4994	Undergraduate Research	
XXXX 3954	Study Abroad	
Legal Foundation Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	
FIW 2514	Fish and Wildlife Conservation Policy	
FREC 4434	Natural Resource Policy	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Writing Restricted Elective		
Select one of the following:		3
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Subtotal		15
Option Required Courses		
Education, Outreach, & Interpretation Restricted Elective		
Select one of the following:		3
ALCE 3004	Educational Programs in Agricultural and Life Sciences	
ALCE 4014	Introduction to Cooperative Extension	
ALCE 4304	Community Education and Development	
FREC 3524	Environmental Interpretation	
FREC 3574	Environmental Education Service Learning	
Stakeholder Engagement & Conflict Resolution Restricted Elective		
Select one of the following:		3
FIW 4454	Human-Wildlife Conflicts	
PSVP 2044	Peace and Violence	
RLCL 3204	Multicultural Communication	
SOC 2034	Diversity and Community Engagement	
SPIA 1024	Community Service Learning	
SPIA 2554	Collaborative Policy-Making and Planning	
STS 3104	Science and Technology in Modern Society	
Ethics & Humanities Restricted Elective		
Select one of the following:		3
HIST 3144	American Environmental History	
PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	
STS 3705	History of Science	
UAP 4264	Environmental Ethics and Policy	
WATR 2004	Water, Environment, and Society	
Social Sciences Restricted Elective		
Select one of the following:		3
FIW 2334	Urbanization and Biodiversity Conservation	
GEOG 4414	Climate Change and Societal Impacts	
AAEC 3324	Environment and Sustainable Development Economics	
APS 3464	Appalachian Communities	
GEOG 3104	Environmental Justice, Resources and Development	
HIST 2604	Introduction to Data in Social Context	
SOC 2024	Sociology of Race and Ethnicity	

SOC 3314	Social Movements	
STS 2454	Science, Techology, and Environment	
STS 3334	Energy and Society	
Tourism, Recreation & Management		
Select one of the following:		3
FIW 2234	Fish, Fishing, and Conservation	
FREC 3544	Outdoor Recreation Planning and Management	
HTM 2454	Global Travel & Tourism Management	
HTM 4484	International Tourism	
HTM 3484	Socio-Cultural Impacts of Tourism	
Subtotal		15
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		**6**
Subtotal		6
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3634	Communicating Ag and Life Sciences in Speaking (1A)	3
or COMM 2004	Public Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select one of the following:		3
FREC 2554	Leadership for Global Sustainability (Recommended for Human Dimensions option)	
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Select one of the following:		3
AAEC 1005	Economics of the Food and Fiber System	
or AAEC 100	Economics of the Food and Fiber System	
ECON 2005	Principles of Economics	
or ECON 2006	Principles of Economics	
Pathway Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6
MATH 1025	Elementary Calculus (5F)	
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	
or MATH 122	Calculus of a Single Variable	
STAT 3604	Statistics for Social Science (5A)	3
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

Satisfactory Progress

1. By the end of the semester in which they have attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), students must pass the courses listed in item number 1 of graduation requirements above (or their equivalents).
2. To remain in good standing, a student must achieve and maintain an overall and in-major cumulative GPA of at least 2.0. Courses used for the in-major GPA computation include all those designated as FIW, FREC, GEOG, NR, and SBIO. To graduate, a student must achieve an overall and in-major cumulative GPA of at least 2.0.

Graduation Requirements

Minimum hours for degree is 120. A minimum cumulative GPA of 2.0 is required for all work applied to the major

Major Requirements:

1. To earn a B.S. degree in Fish Conservation, a student must pass the following courses, or their equivalents, with a grade of C - or better: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory , and FIW 2114 Principles of Fish and Wildlife Conservation.
2. There are no hidden prerequisites on this check sheet; however, course requirements may change over time, and students should always check for prerequisites for classes they select.
3. Students should consult www.fishwild.vt.edu/experiential_learning.html (http://www.fishwild.vt.edu/experiential_learning.html) for more details on how to fulfill the experiential learning requirement. Note that you will not receive credit for your experiential learning until **all** the documents related to the experience are completed and submitted, in addition to being registered for the experience. Students enrolling in FIW 2974 Independent Study, FIW 3964 Internship Through Directed Field Study, or FIW 4974 Independent Study should use the P/F option; FIW 2994 Undergraduate Research, FIW 4994 Undergraduate Research and XXXX 3954 may be taken P/F or A/F.
4. FIW 2514 Fish and Wildlife Conservation Policy is one option for the Legal Foundation Restricted Elective, under Additional Major Requirements, and it can also serve as an option for 3 credit hours under Pathways Concept 3 requirements.
5. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways).

Foreign Language Requirement

University Requirements—Foreign Language Policy Complete an 1105-1106 foreign language (e.g., FR, GR, SPAN) grouping or the equivalent.

1.

Fish Conservation Major with Marine Fisheries Conservation Option

Program Curriculum

Minimum hours for degree is 120. A minimum cumulative GPA of 2.0 is required for all work applied to the major

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2704	Evolutionary Biology	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FIW 4414	Population Dynamics and Estimation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
Select one of the following:		4
FIW 4314	Conservation of Biological Diversity (Wildlife Majors)	
or FIW 4714	Fisheries Management	
Select one of the following:		
NR 1234	First Year Experience In Natural Resources and Environment	2-3
or NR 2234	1st Semester Experience-Transfer Students in Natural Resources and Environment	
Subtotal		20-21
Additional Degree Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Experiential Learning Requirement		
Select one of the following: (requires department approval)		1
FIW 2974	Independent Study	
FIW 2994	Undergraduate Research	
FIW 3964	Internship Through Directed Field Study	
FIW 4974	Independent Study	
FIW 4994	Undergraduate Research	
XXXX 3954	(Study Abroad)	
Legal Foundation Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	
FIW 2514	Fish and Wildlife Conservation Policy	
FREC 4434	Natural Resource Policy	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Writing Restricted Elective		
Select one of the following:		3
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Subtotal		15
Major Requirements		
BIOL 2804	Ecology	3
FIW 3514	Fisheries Techniques	3
FIW 4424	Ichthyology	4
FIW 4614	Fish Ecology	3
Geographic Information Systems Restricted Elective		
Select one of the following:		3
FREC 4114	Information Technologies for Natural Resource Management	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
GEOG 2084	Principles of Geographic Information Systems	
GEOG 4354	Introduction to Remote Sensing	
GEOS 3034	Oceanography	3
Subtotal		19
Option Required Courses		
FIW/FREC 4324	Genetics of Natural and Mangaged Populations	3
FIW 4624	Marine Ecology	3
STAT 3616	Biological Statistics	3
Select approved marine science courses at a collaborating institution (minimum of 10 credits)		10
Subtotal		19
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		
Select free electives to total 120 credits		2
Subtotal		2
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3634	Communicating Ag and Life Sciences in Speaking (1A)	3
or COMM 2004	Public Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select one of the following:		3
FREC/LAR/NR 2554	Leadership for Global Sustainability	
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select one of the following:		6
AAEC 1005	Economics of the Food and Fiber System	
or AAEC 100	Economics of the Food and Fiber System	
ECON 2005	Principles of Economics	
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6

MATH 1025 & MATH 1026	Elementary Calculus and Elementary Calculus (5F)	
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (5F)	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

1.

By the end of the semester in which they have attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), students must must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory and FIW 2114 Principles of Fish and Wildlife Conservation.

Graduation Requirements

1. **Major Requirements:**
   To earn a B.S. degree in Fish Conservation, a student must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory and FIW 2114 Principles of Fish and Wildlife Conservation.

   There are no hidden prerequisites on this check sheet; however, course requirements may change over time, and students should always check for prerequisites for classes they select.

   Students should consult www.fishwild.vt.edu/experiential_learning.html (http://www.fishwild.vt.edu/experiential_learning.html) for more details on how to fulfill the experiential learning requirement. Note that you will not receive credit for your experiential learning until **all** the documents related to the experience are completed and submitted, in addition to being registered for the experience. Students enrolling in FIW 2974, FIW 3964, or FIW 4974 should use the P/F option; FIW 2994, FIW 4994 and XXXX 3954 may be taken P/F or A/F.

   To remain in good standing, a student must achieve and maintain an overall and in-major cumulative GPA of at least 2.0. Courses used for the in-major GPA computation include all those designated as FIW, FREC, GEOG, NR, and SBIO. To graduate, a student must achieve an overall and in-major cumulative GPA of at least 2.0.
2. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways).

Foreign Language Requirement

A sequence of two (2) foreign language courses is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation.

Wildlife Conservation Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2704	Evolutionary Biology	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
Select one of the following:		4
FIW 4314	Conservation of Biological Diversity (Wildlife Majors)	
FIW 4714	Fisheries Management (Fisheries Majors)	
FIW 4414	Population Dynamics and Estimation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
NR 1234	First Year Experience In Natural Resources and Environment	2-3
or NR 2234	1st Semester Experience-Transfer Students in Natural Resources and Environment	
Subtotal		20-21
Major Requirements		
Select one of the following:		3
BIOL 3204	Plant Taxonomy	
HORT 3324	Herbaceous Landscape Plants	
HORT 3326	Woody Landscape Plants	
FIW 2314	Wildlife Biology	3
FIW 2324	Wildlife Field Biology	3
FIW 4214	Wildlife Field Techniques	3
FIW 4434	Wildlife Habitat Ecology and Management	3
FREC 2324	Dendrology Laboratory	1
Vertebrate Biology Restricted Elective		
Select one of the following: (must include labs)		4
BIOL 4404	Ornithology	
FIW 4334	Mammalogy	
FIW 4344	Herpetology	
Subtotal		20
Additional Degree Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Experiential Learning Requirement		
Select one of the following: (requires department approval)		1
FIW 2974	Independent Study	
FIW 2994	Undergraduate Research	
FIW 3964	Internship Through Directed Field Study	
FIW 4974	Independent Study	

FIW 4994	Undergraduate Research	
XXXX 3954	(Study Abroad)	
Legal Foundation Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	
FIW 2514	Fish and Wildlife Conservation Policy	
FREC 4434	Natural Resource Policy	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Writing Restricted Elective		
Select one of the following:		3
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Subtotal		15
Additional Wildlife Conservation Requirements		
FIW 4474	Wildlife Habitat Evaluation	1
Additional Vertebrate Biology Restricted Elective		
Select one of the following: (must include labs)		4
BIOL 4404	Ornithology	
FIW 4334	Mammalogy	
FIW 4344	Herpetology	
BIOL 4354	Aquatic Entomology	
FIW 4424	Ichthyology	
Genetics (choose one)		
FIW 4324	Genetics of Natural and Mangaged Populations	3
or BIOL 2004	Genetics	
Geographic Information Systems Restricted Elective		
Select one of the following:		3
FREC 4114	Information Technologies for Natural Resource Management	
FREC 4214	Forest Photogrammetry and Spatial Data Processing	
GEOG 2084	Principles of Geographic Information Systems	
GEOG 4354	Introduction to Remote Sensing	
Ecology Restricted Elective		
Select one of the following:		3
BIOL 2804	Ecology	
FREC 3314	Forest Ecology and Silvics	
FREC 3364	Environmental Silviculture	
Physical Science Restricted Elective		
Select one of the following:		3-4
CHEM 2514	Survey of Organic Chemistry	
CHEM 2535	Organic Chemistry	
CSES 3114 & CSES 3124	Soils and Soils Laboratory	
ENSC 3134	Soils in the Landscape	
GEOS 1004	Earth Science: Our Past, Present, and Future	
GEOS 3034	Oceanography	
PHYS 2205	General Physics	
PHYS 2206	General Physics	
Subtotal		17-18
Free Electives		
Select 1-3 credits		3
Subtotal		3
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3634	Communicating Ag and Life Sciences in Speaking	3
or COMM 2004	Public Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select one of the following:		3
FREC/LAR/NR 2554	Leadership for Global Sustainability	
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Select one of the following:		3
AAEC 1005	Economics of the Food and Fiber System	
or AAEC 1006	Economics of the Food and Fiber System	
ECON 2005	Principles of Economics	
or ECON 200	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6
MATH 1025	Elementary Calculus (5F)	
or MATH 12	Calculus of a Single Variable	
MATH 1026	Elementary Calculus	
or MATH 122	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-122**

To remain in good academic standing, a student must achieve and maintain an overall and in-major cumulative GPA of at least 2.0. Courses used for the in-major GPA computation include all those designated as FIW, FREC, GEOG, NR, and SBIO. To graduate, a student must achieve an overall and in-major cumulative GPA of at least 2.0.

In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways).

By the end of the semester in which they have attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), students must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, FREC 2324 and FIW 2114.

Graduation Requirements

Minimum hours for degree is 120. A minimum cumulative GPA of 2.0 is required for all work applied to the major.

Major Requirements:
1) To earn a B.S. degree in Wildlife Conservation, a student must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, FREC 2324 and FIW 2114.
There are no hidden prerequisites on this check sheet; however, course requirements may change over time, and students should always check for prerequisites for classes they select.
2) Students should consult www.fishwild.vt.edu/experiential_learning.html (http://www.fishwild.vt.edu/experiential_learning.html) for more details on how to fulfill the experiential learning requirement. Note that you will not receive credit for your experiential learning until **all** the documents related to the experience are completed and submitted, in addition to being registered for the experience. Students enrolling in FIW 2974, FIW 3964, or FIW 4974 should use the P/F option; FIW 2994, FIW 4994 and XXXX 3954 may be taken P/F or A/F

3) If you plan to apply for The Wildlife Society Associate Wildlife Biologist certification, be aware that all courses used in the certification application must be passed with a C- or better beginning with applications submitted in 2023.

Foreign Language Requirement

A sequence of two (2) foreign language courses is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on “Graduation Requirements.”

1.

Wildlife Conservation Major with Human Dimensions Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
BIOL 2704	Evolutionary Biology	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
Select one of the following:		4
FIW 4314	Conservation of Biological Diversity (Wildlife Majors)	
FIW 4714	Fisheries Management (Fisheries Majors)	
FIW 4414	Population Dynamics and Estimation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife	3
NR 1234	First Year Experience In Natural Resources and Environment	2-3
or NR 2234	1st Semester Experience-Transfer Students in Natural Resources and Environment	
Subtotal		20-21
Major Requirements		
Select one of the following:		3
BIOL 3204	Plant Taxonomy	
HORT 3324	Herbaceous Landscape Plants	
HORT 3326	Woody Landscape Plants	
FIW 2314	Wildlife Biology	3
FIW 2324	Wildlife Field Biology	3
FIW 4214	Wildlife Field Techniques	3
FIW 4434	Wildlife Habitat Ecology and Management	3
FREC 2324	Dendrology Laboratory	1
Vertebrate Biology Restricted Elective		
Select one of the following: (must include labs)		4
BIOL 4404	Ornithology	
FIW 4334	Mammalogy	
FIW 4344	Herpetology	
Subtotal		20
Additional Degree Requirements		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
Experiential Learning Requirement		
Select one of the following: (requires department approval)		1
FIW 2974	Independent Study	
FIW 2994	Undergraduate Research	
FIW 3964	Internship Through Directed Field Study	
FIW 4974	Independent Study	
FIW 4994	Undergraduate Research	
XXXX 3954	Study Abroad	
Legal Foundation Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	
FIW 2514	Fish and Wildlife Conservation Policy	
FREC 4434	Natural Resource Policy	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4344	Law of Critical Environmental Areas	
Writing Restricted Elective		
Select one of the following:		3
ALCE 3624	Communicating Ag and Life Sciences in Writing	
ENGL 3764	Technical Writing	
ENGL 3774	Business Writing	
Subtotal		15

Option Required Courses		
Education, Outreach, & Interpretation Restricted Elective		
Select one of the following:		3
ALCE 3004	Educational Programs in Agricultural and Life Sciences	
ALCE 4014	Introduction to Cooperative Extension	
ALCE 4304	Community Education and Development	
FREC 3524	Environmental Interpretation	
FREC 3574	Environmental Education Service Learning	
Stakeholder Engagement & Conflict Resolution Restricted Elective		
Select one of the following:		3
FIW 4454	Human-Wildlife Conflicts	
PSVP 2044	Peace and Violence	
RLCL/HUM 3204	Multicultural Communication	
SOC 2034	Diversity and Community Engagement	
SPIA 1024	Community Service Learning	
SPIA 2554	Collaborative Policy-Making and Planning	
STS 3104	Science and Technology in Modern Society	
Ethics & Humanities Restricted Elective		
Select one of the following:		3
HIST 3144	American Environmental History	
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	
STS/HIST 3705	History of Science	
UAP 4264	Environmental Ethics and Policy	
WATR/GEOG 2004	Water, Environment, and Society	
Social Sciences Restricted Elective		
Select one of the following:		3
FIW 2334	Urbanization and Biodiversity Conservation	
GEOG 4414	Climate Change and Societal Impacts	
AAEC 3324	Environment and Sustainable Development Economics	
APS/AHRM/ GEOG/HD/ HUM/SOC/ UAP 3464	Appalachian Communities	
GEOG 3104	Environmental Justice, Resources and Development	
HIST/SOC/ STS 2604	Introduction to Data in Social Context	
SOC 2024	Sociology of Race and Ethnicity	
SOC 3314	Social Movements	
STS 2454	Science, Techology, and Environment	
STS 3334	Energy and Society	
Tourism, Recreation & Management		
Select one of the following:		3
FIW 2234	Fish, Fishing, and Conservation	
FREC 3544	Outdoor Recreation Planning and Management	
HTM 2454	Global Travel & Tourism Management	
HTM 4484	International Tourism	
HTM 3484	Socio-Cultural Impacts of Tourism	
Subtotal		15
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		**5**
Subtotal		5
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ALCE 3634	Communicating Ag and Life Sciences in Speaking (1A)	3
or COMM 2004	Public Speaking	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Select one of the following:		3
FREC/LAR/NR 2554	Leadership for Global Sustainability (Recommended for Human Dimensions option)	
PHIL 1304	Morality and Justice	
PHIL 2304	Global Ethics	
Pathways Concept 3 - Reasoning in the Social Sciences		
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Select one of the following:		3
AAEC 1005	Economics of the Food and Fiber System	
or AAEC 1006	Economics of the Food and Fiber System	
ECON 2005	Principles of Economics	
or ECON 200	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select one of the following:		6
MATH 1025	Elementary Calculus (5F)	
or MATH 12	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	
or MATH 122	Calculus of a Single Variable	
STAT 3604	Statistics for Social Science (5A)	3
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-121**

1. By the end of the semester in which they have attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), students must pass the courses (or their

equivalents) listed in item number 1 in graduation requirements section above.

Graduation Requirements

Minimum hours for degree is 120. A minimum cumulative GPA of 2.0 is required for all work applied to the major.

1. To earn a B.S. degree in Wildlife Conservation, a student must pass the following courses, or their equivalents, with a **grade of C - or better**: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, FREC 2324 Dendrology Laboratory and FIW 2114 Principles of Fish and Wildlife Conservation.

   There are no hidden prerequisites on this check sheet; however, course requirements may change over time, and students should always check for prerequisites for classes they select.
2. Students should consult www.fishwild.vt.edu/experiential_learning.html (http://www.fishwild.vt.edu/experiential_learning.html) for more details on how to fulfill the experiential learning requirement. Note that you will not receive credit for your experiential learning until **all** the documents related to the experience are completed and submitted, in addition to being registered for the experience. Students enrolling in FIW 2974 Independent Study, FIW 3964 Internship Through Directed Field Study, or FIW 4974 Independent Study should use the P/F option; FIW 2994 Undergraduate Research, FIW 4994 Undergraduate Research and XXXX 3954 may be taken P/F or A/F.
3. To remain in good standing, a student must achieve and maintain an overall and in-major cumulative GPA of at least 2.0. Courses used for the in-major GPA computation include all those designated as FIW, FREC, GEOG, NR, and SBIO. To graduate, a student must achieve an overall and in-major cumulative GPA of at least 2.0.
4. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways).
5. If you plan to apply for The Wildlife Society Associate Wildlife Biologist certification, be aware that all courses used in the certification application must be passed with a C- or better beginning with applications submitted in 2023.
6. FIW 2514 Fish and Wildlife Conservation Policy is one option for the Legal Foundation Restricted Elective, under Additional Degree Requirements, and it can also serve as an option for 3 credit hours under Pathways Concept 3 requirements.
7. HORT 3324 Herbaceous Landscape Plants and HORT 3326 Woody Landscape Plants will be opened to WLC students only during the Add/Drop registration period when seats are available.

Foreign Language Requirement

A sequence of two (2) foreign language courses is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on “Graduation Requirements.”

1.

Forest Resources and Environmental Conservation

Our Website (http://www.frec.vt.edu)

Environmental Data Science

Environmental Informatics applies data analysis, computational modeling, and information science to study the environment and manage natural resources. Students in the Environmental Informatics major gain expertise in the environment and in the computational and analytical approaches to solve environmental challenges, including geographic information, mathematical and statistical modeling, remote sensing, database management, knowledge integration, and decision making.

Forest Resource Management

Programs of study in Forestry include three options focused on forest management and are accredited by the Society of American Foresters (SAF), the national scientific and educational organization representing the forestry profession in the United States.

Students in the Forest Resources Management Option gain expertise in the biological and social sciences needed to make sound management decisions concerning regeneration, growth, protection, management, and sustainability of forest ecosystems. Graduates pursue careers in the forest industry, public agencies, non-governmental agencies, and private forestry companies.

In the Forest Operations and Business Option, students prepare to take an active role in assuring that the sale, harvest, and conversion of standing timber to products is done in an efficient, economic, safe, and environmentally sound manner. Graduates pursue careers in forest industry, national and state forest services, forestry consulting firms, and the equipment industry.

Students in the Urban Forestry Option gain expertise in the management of forest resources in cities, towns, and other urbanized environments. The program emphasizes interdisciplinary perspectives and students take classes in Horticulture, Landscape Architecture, and Urban Affairs and Planning to customize a curriculum that supports their career goals. Graduates pursue careers in municipal forestry, commercial tree care, utility vegetation management, urban environmental consulting, public agencies, and nonprofit organizations.

Environmental Resource Management

Students in the Environmental Resource Management Major gain expertise in managing environmental resources from a wide variety of environmental perspectives, including forest resources, soils, water, environmental law, policy and planning, and environmental economics. Graduates pursue careers in public agencies, private industry, and firms that deal with forested wetland protection, endangered species, the urban-rural interface, and sustainability.

Environmental Conservation and Society

Programs of study in Environmental Conservation and Society prepare students for a broad array of natural resource careers with an emphasis on social sciences and public communication.

The Recreation and Tourism Management Option prepares students to be the managers, planners, and program administrators who deal with today's complex conservation challenges. Courses in ecological, natural,

and social sciences, planning, tourism, and business management, are combined with a deep understanding of recreation resources. Graduates pursue careers in government and non-government organizations as well as commercial recreation and green businesses.

The Education and Outreach Option offers a balance of natural sciences, social sciences, and the humanities to give students a well-rounded base of knowledge about the natural world. Graduates pursue careers in nature education, environmental interpretation, resource education, and communications, or they may pursue a license for an elementary education career.

Water: Resources, Policy, and Management

The Water: Resources, Policy, and Management degree addresses the protection and development of water resources by providing the interdisciplinary training required to meet water challenges and opportunities now and in the future.

- Environmental Conservation & Society Major (p. 1186)
- Environmental Data Science Major (p. 1189)
- Environmental Resources Management Major (p. 1191)
- Forestry Major (p. 1193)
- Water: Resources, Policy, and Management Major (p. 1195)

University Distinguished Professor: H. E. Burkhart
Alumni Distinguished Professor: J. R. Seiler
Julian N. Cheatham Professor: G. S. Amacher
Honorable Garland Gray Professor: W. M. Aust
Professors: M. C. Bolding, R. B. Hull, K. J. McGuire, J. F. Munsell, S. H. Schoenholtz, M. J. Stern, J. Sullivan, V. A. Thomas, and R. H. Wynne
Associate Professors: S. M. Barrett, A. M. Brunner, K. M. Cobourn, C. A. Copenheaver, J. A. Holliday, J. A. McGee, D. L. McLaughlin, P. J. Radtke, M. G. Sorice, B. D. Strahm, R. Q. Thomas, and P. E. Wiseman
Assistant Professors: D. R. Carter, T.A. Coates, and S. Z. Schons
Collegiate Assistant Professor: J. P. Gannon
Adjunct Faculty: C. Anderson, S. Bailey, G. Busby, D. Chojnacky, J. W. Coulston, A. J. Finkral, J. Knoepp, W. Lakel, C. Maier, R. Rubilar, E. Schilling, D. Soucek, and J. Westfall
Courtesy Appointments: D. Robertson, R. J. Harris, R. Jones, P. Miller, and S. M. Salom

Undergraduate Course Descriptions (FREC)

FREC 1004 - Digital Planet (3 credits)
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 1084

FREC 1044 - Introduction to Environmental Data Science (3 credits)
Application of data science to environmental management. Role of data science, mathematical and statistical modeling, geospatial technology, database management, knowledge integration, and decision science in environmental decision-making. Skills and techniques required to assist scientists and managers with the challenges of collecting, collating, archiving, modeling, analyzing, visualizing, and communicating data in support of natural resource management.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2004 - Forest Ecosystems (3 credits)
Introduction to forest ecosystem ecology. Global forest cover, types, distribution, and change. Relationships among forest structure, function, and biodiversity. Interactions among rock, soil, water, air, and the organisms that define and inhabit forests around the world. Energy, water, carbon, and nutrient fluxes from leaf to global scales. Connections among forests, society, and global change. Capacity of forests to sustainably provide ecosystem services.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2114 - Ecology of Appalachian Forests (3 credits)
Introduction to the natural history, tree biology, tree identification, forest ecology, management and forest types of the Appalachian region. Contemporary issues related to forest functions will be discussed including carbon storage, climate change, invasive forest species, wildlife management, fire, biofuels, agroforestry, urban forests, ecosystem restoration, clean water, recreation, and use of renewable resources.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2124 - Forests, Society & Climate (3 credits)
Role of forest ecosystems on the global carbon cycle, climate, biodiversity and economies. Anthropogenic impacts on forest ecosystems and their ecological function in the face of changing climate. Regional and cultural implications for the state of the forests and deforestation-related policy. Climate-related threats to global forests, including loss of biodiversity, deforestation, forest fires, and invasive species. Sustainable forest management for anticipated future scenarios.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2134 - Plants and Greenspaces in Urban Communities (3 credits)
Modern concepts of sustainability changing plant use in urban settings. Fundamentals of urban plant systems in the context of urban ecosystem management. Philosophy and critical analysis of sustainability related to green infrastructure, including urban forests, green roofs, urban soils, urban wildlife, urban agriculture, and innovations merging plant and ecosystem functions with building and site engineering. Multi-disciplinary emphasis at site, regional, and global, scales.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 2134

FREC 2214 - Introduction to Land and Field Measurements (3 credits)
Measurement of land and field attributes including geographic position, land distance, direction, area, slope, elevation and boundary attributes. Use and development of maps used in natural resource applications. Use of global positioning systems and geographic information systems in the acquisition and management of land and field measurements. Assessment of vegetation attributes with field plots. Use of computer software to manage and analyze data and present results.
Prerequisite(s): MATH 1025 or MATH 1225 or MATH 1524
Corequisite(s): FREC 2324
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 2254 - Arboriculture Field Skills (1 credit)
Field observation, discussion, and practice of skills employed in the management of urban landscape trees. Hands-on experience with tree pruning, removal, pest control, fertilization, cabling/bracing, lightning protection, and climbing. Emphasis on arborist safety, professional ethics, and best management practices. Guest instruction provided in part by professionals working in the tree care industry.
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 2314 - Forest Biology and Dendrology (2 credits)
Introduction to the botany, physiology, genetics and silvics of important forest trees of North America.
Prerequisite(s): BIOL 1106
Instructional Contact Hours: (2 Lec, 2 Crd)

FREC 2324 - Dendrology Laboratory (1 credit)
Field identification of trees of North America with particular emphasis on trees native to the Eastern United States.
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 2414 - Field Experience in Forest Resources and Environmental Conservation (2 credits)
Field exercises to develop skills needed to sustainably manage forest and environmental resources including navigation and mapping, inventory of timber and non-timber resources, soil and water conservation, forest and recreation management, forest operations and timber harvesting. Fee $216.
Instructional Contact Hours: (6 Lab, 2 Crd)

FREC 2514 - Wildland Fire: Ecology and Management (3 credits)
Provide students with basic knowledge on how: fire has an impact on forest environments; the environment and weather influence fire behavior; wildland fires are suppressed; and fire is used as a land and vegetation management tool. The course will also provide students with the knowledge and training to qualify as a basic wildland firefighter (FFT2-Red Card). Extended laboratory sessions will provide practice in fire behavior prediction, prescribed burning techniques, and fire control methodology. COURSE FEE: $110.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 2554 - Leadership for Global Sustainability (3 credits)
Leadership principles and humanities perspectives that help examine and engage global sustainable development challenges such as climate change, food-water-energy nexus, rising middle class, circular economy, and environmental justice. Topics include collaboration, stories, conflict resolution, self-awareness, bias, equity, religion, hubris, globalism, and moral naturalism. Examine trade-offs among economic, environmental, and social dimensions of sustainable development. Integration and application of disciplinary topics including ethics, ecology, evolution, anthropology, economics, religion, aesthetics, and risk management.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: LAR 2554, NR 2554

FREC 2614 - Human-Environment Systems (3 credits)
Social and ecological dynamics of human-environment systems. Effect of complex environmental problems on ecosystems and human well-being. Introduction to systems thinking. History, philosophy, and application of decision making in the field of natural resource management. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 2784 - Global Forest Sustainability (3 credits)
A socio-economic approach to examining the management and use of the worlds forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 2784

FREC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 3044 - Environmental Data Science (3 credits)
Applications of the analysis and modeling of environmental datasets at multiple spatial-temporal scales to study environmental issues of societal importance. Computer programing is used in the acquisition, analysis, visualization, and storage of environmental data. Modeling techniques include regression, classification, and numerical simulation. Ethics and methods of data curation, quality control, analysis, and sharing.
Prerequisite(s): FREC 1044 or CMDA 2014 or CMDA 3654 or CS 3654 or STAT 3654
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3104 - Principles of Watershed Hydrology (3 credits)
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earths surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing
Prerequisite(s): MATH 1026 or MATH 1226 or STAT 3005 or STAT 3604 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 3104

FREC 3214 - Forest Biometrics (3 credits)
Statistical and mathematical basis for collecting and analyzing data used to make valid inferences and ethical decisions in applications of forest ecosystem science and management. Principles and practices of forest inventory and probability-based sampling. Computational and mathematical tools for analyzing field data. Statistical summarization, estimation, hypothesis testing, and inference from data collected in forest inventories.
Prerequisite(s): FREC 2214 and (MATH 1026 or MATH 1226)
Corequisite(s): FREC 3224
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3224 - Forest Measurements Field Laboratory (1 credit)
Field practice and computer analysis for collecting and analyzing survey data for use in forest management. Forest inventory and probability-based sampling, stratified sampling, double sampling, regression, and census-based sampling applications. Computer and geospatial tools for analyzing field data. Field assessment of tree and log contents, stand density, and site index. Collection and analysis of growth and yield data.
Prerequisite(s): (FREC 2214 or FOR 2214) and (FREC 2414 or FOR 2414)
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 3314 - Forest Ecology and Silvics (3 credits)
Environmental factors affecting the establishment, growth, and development of forests; silvical characteristics of trees; forest community structure and function; forest ecosystem analysis. COURSE FEE: $48.
Prerequisite(s): (FREC 2314 or FOR 2314) and (FREC 2214 or FOR 2214)
Instructional Contact Hours: (2 Lec, 4 Lab, 3 Crd)

FREC 3324 - Silviculture Principles and Applications (4 credits)
Theory and practices involved in controlling forest establishment, composition, and growth are developed in a regional context. Formulation of silvicultural systems and the study of reproduction methods, site preparation, intermediate stand manipulations, and reforestation operations.
Prerequisite(s): FREC 3314 or FOR 3314
Instructional Contact Hours: (3 Lec, 4 Lab, 4 Crd)

FREC 3354 - Trees in the Built Environment (3 credits)
Science and practice of tree cultivation, conservation, and management in human-dominated environments along an urban to rural gradient. Holistic study of landscape tree management: planning, planting, inspection, maintenance, removal, and wood waste utilization. Examination of tree responses to urbanization and tree influences on built environments. Emphasis on sustainable, ethical stewardship of landscape trees for the benefit of people and the environment.
Prerequisite(s): (FREC 2314 or BIOL 2304 or HORT 2304) and (FREC 2324 or HORT 3325 or HORT 3326)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 3354

FREC 3364 - Environmental Silviculture (3 credits)
Science and design of sustainable management of forests to meet the needs of a globalized society. Historic and current intercultural and socio-economic factors influencing stakeholder objectives and the shape, value, pattern, composition, structure, and function of forests domestically and abroad. Tools used to design forests and management plans to address global challenges. Design thinking process: gather stakeholder input, brainstorm/analyze ideas, develop potential solutions, test their working hypothesis or prototype in a computer simulation, and iterate/improve toward a sustainable solution.
Prerequisite(s): FREC 2324
Pathway Concept Area(s): 6D Critique & Prac in Design, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3454 - Trees in the Built Environment Lab (1 credit)
Hands-on experience in the cultivation, conservation, and management of landscape trees in human-dominated environments along the urban to rural gradient. Field exercises in tree inventory, appraisal, disorder diagnosis, planting, pruning, and protection. Emphasis on use of scientific methods and best management practices to ensure tree health, safety, and functionality for the benefit of people and the environment. Methods of communicating technical information and management recommendations for landscape trees through written media.
Corequisite(s): FREC 3354
Instructional Contact Hours: (3 Lab, 1 Crd)

FREC 3524 - Environmental Interpretation (3 credits)
Interpretation theory and techniques as relevant to natural resource management; culturally appropriate program planning and evaluation; role of interpretation in enhancing visitor experiences and promoting stewardship. Pre: Junior standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3544 - Outdoor Recreation Planning and Management (3 credits)
Planning and management of nature-dependent outdoor recreation. History, philosophy and benefits of nature-dependent outdoor recreation. Environmental and social impacts of recreational uses. Techniques to manage visitor impact. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 3574 - Environmental Education Service Learning (3 credits)
Introduction to key concepts in environmental education and teaching skills through lecture, discussion, service learning, and reflection. Training in internationally recognized environmental education curricula (e.g. Project Learning Tree, Project Wet), in class management and organization skills and in theory relevant to both teaching and learning. Students develop and conduct after school environmental education programs at local elementary schools
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3714 - Forest Harvesting (3 credits)
Principles and application of forest harvesting. Terminology, phases, function, and the interrelationships of people, money, machines, and environment. COURSE FEE: $60.
Prerequisite(s): FREC 2214 or FOR 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3724 - Forest Boundaries and Roads (3 credits)
Application of basic land surveying and forest measurement techniques to the location, establishment, and maintenance of forest boundaries and roads. Consideration of stream crossings, best management practices, and costs. Fee $187.
Prerequisite(s): FREC 2214 or FOR 2214
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3734 - Forest Fiber Supply (3 credits)
Analysis of the southeastern U.S. forest industry fiber supply process with emphasis on the evolution and dynamics of timber procurement systems, strategies, business principles, ethical dilemmas, and professional practices. Field exercises and case studies to ethically appraise timber sales. Analysis of current industrial operations and practices. Discourse-based project resulting in the writing, presenting, and critiquing of procurement plans. Pre: Junior standing. COURSE FEE: $365
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 3754 - Watersheds and Water Quality Monitoring (3 credits)
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems.
Prerequisite(s): (BIOL 1106 or BIOL 1006) and CHEM 1035 and (FREC 2004 or FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 3754

FREC 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 3964 - Internship Through Directed Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

FREC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4004 - Professional Skills in Natural Resources (1 credit)
Elements of professionalism and principles of success across a wide spectrum of natural resources careers. Skills for ethical and professional interaction including effective communication, advancement of diversity and inclusion, and personal responsibility. Career preparation principles including employer outreach, job seeking, resume writing, and interview preparation. Guest speakers from academia, industry, and government. Pre: Senior standing.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: NR 4004

FREC 4014 - Natural Resources Economics (3 credits)
Examination of domestic and international natural resource use, exploitation, and degradation problems, with special focus on use of economics to understand why potential overuse of natural resources exists, and what policy options are available to correct these problems and ensure sustainable natural resource use over time. Water, forests, fisheries, land and exhaustible resources. Permission of instructor may be substituted for the pre-requisite.
Prerequisite(s): ECON 2005 or AAEC 1005
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 4014

FREC 4024 - Forest Resources Management and Business (3 credits)
Forest management and business principles, theory, and methods to support sound decision-making in forestry: from the level of the forest to the business organization as a whole. Capital budgeting methods to prescribe forest harvest schedules and perform forest finance analyses. Forest industry structure, trends, and future performance. Strategic management frameworks (e.g. SWOT (Strengths, Weaknesses, Opportunities, and Threats), PIE (Potential, Importance and Ease) and Porter's Five Forces) and the influence of public policy and regulation on forest business strategy. Ethics, sustainability and corporate social responsibility applied to real forest business problems.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4044 - Environmental Data Science Capstone (3 credits)
Apply environmental data science strategies and techniques to natural resources problems. Capstone experience using spatial and/or temporal environmental data. Integrate multiple concepts and strategies to create a practical solution.
Prerequisite(s): FREC 3004 or FREC 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4114 - Information Technologies for Natural Resource Management (3 credits)
An introduction to computer information systems used in natural resources management. Course will introduce students to the theory and applications of database management systems (DBMS) and geographic information systems (GIS). Uses, challenges, and limitations of these technologies in natural resource management applications will be discussed. Students will receive extensive hand-on instruction in the use of current software packages for DBMS and GIS.
Prerequisite(s): FREC 2214 or FOR 2214 or GEOG 2314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4134 - Forest Carbon Management and Policy (3 credits)
Importance of forests in the global carbon cycle. Measuring, reporting, and verification (MRV) of forest carbon stocks and fluxes. National, regional and international forest carbon markets. Main national and international forest-based carbon policies and programs, such as REDD +. Impacts of forest management practices by landowners and policies on forest carbon stocks. Economic viability of forest carbon projects. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4174 - Climate Change and the International Policy Framework (3 credits)
Science, causes and impacts of climate change. Mitigation and adaptation measures to address the causes and impacts of climate change. International climate change policy, with attention to the policy making process, in particular the role of the United Nations Framework Convention on Climate Change and climate negotiations. Science and diplomacy in climate negotiations to achieve successful outcomes. The ethical and social implications of climate change policies.
Pathway Concept Area(s): 1A Discourse Advanced, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 4174, PSCI 4174

FREC 4214 - Forest Photogrammetry and Spatial Data Processing (3 credits)
Films, filters and camera photogeometry; scale; measurement estimation; image processing; flight planning and photo acquisition; geographic information systems; spatial data analysis techniques and applications. Pre: Junior standing.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4244 - Hydroinformatics (3 credits)
Analysis and examination of hydrologic data using basic statistics and computer programming. Calculation and interpretation of flow frequency and duration, hydrologic analysis of geospatial digital terrain data, and implementation and analysis of simple hydrologic models. Advanced methods of temporal and spatial hydrologic data visualization using computer programming.
Prerequisite(s): FREC 3104 or WATR 3104 or FREC 1044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 4244

FREC 4324 - Genetics of Natural and Managed Populations (3 credits)
Introductory genetics with an emphasis on evolutionary processes relevant to natural and managed populations of both plant and animal species. Traditional and modern genetics, including quantitative and population genetics, molecular evolution, genomics, and biotechnology.
Prerequisite(s): BIOL 1105 and BIOL 1106 and (STAT 3005 or STAT 3615 or FREC 3214 or FOR 3214)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FIW 4324

FREC 4334 - Principles and Practice of Agroforestry (3 credits)
Biological, social, economic, and technical aspects of agroforestry, training and technology transfer techniques, and application of forestry and agriculture principles. Roles of animals and fish, trees, and agricultural crops in agroforestry systems. Community involvement in planning and implementation of agroforestry projects. COURSE FEE: $40.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 4334

FREC 4354 - Forest Soil and Watershed Management (3 credits)
Properties and processes of soil and water in forests. Emphasis on management for the delivery of ecosystem services at local to global scales. Includes analysis and interpretation in field and laboratory.
Prerequisite(s): CSES 3114 or FREC 2004 or GEOS 3614 or ENSC 3134
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4364 - Advanced Silviculture and Forest Vegetation Management (3 credits)
Advanced topics in silviculture with an emphasis on species silvical differences; forest vegetation management and control, herbicides used in forestry, their chemistry, toxicology, application technology; environmental considerations; tree improvement, individual tree growth, and stand dynamics as affected by intermediate silvicultural operations; implications of atmospheric deposition.
Prerequisite(s): FREC 3324 or FOR 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4374 - Forested Wetlands (3 credits)
Classifications, jurisdictional delineation, and management options of forested wetlands. Relationship of hydrology, soils, and vegetation to ecosystem processes, societal values, and management with regard to environmental and legal considerations and best management practices. Emphasis is on forested wetlands in the southern U.S., but national and international wetlands are included. COURSE FEE: $187.
Prerequisite(s): FREC 4354 or CSES 3114 or ENSC 3114 or GEOS 3614 or CSES 3134 or ENSC 3134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4414 - Advanced Wildland Fire Management (3 credits)
Impacts fire has on forest environments; how the environment influences fire behavior; how computer programs aid fire decision making; and how fire is used as a land and vegetation management tool. Influences of weather on fire behavior. The course will also provide students with the knowledge and training to qualify as an advanced wildland firefighter (Squad Boss) (FFT1 - Red Card) and a Virginia Certified Prescribed Burn Manager.
Prerequisite(s): FREC 2514 or FOR 2514
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4424 - Forest Resources Economics and Management (3 credits)
Application of economics principles and tools to forest decision making from the individual tract to large private and public holdings. Private and public landowner financial incentives and decisions, forest amenities, non-timber forest products, risk, multiple use, management and ownership trends, and sustainability are examined. Prerequisite course or consent of instructor.
Prerequisite(s): FREC 3324 or FOR 3324 or FREC 3364 or FOR 3364
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4434 - Natural Resource Policy (3 credits)
Historical development of U.S. natural resource policy. Application of policy analysis tools to understand the factors driving natural resource policy formation at the federal, state, and local level. Evaluation of the effects of alternative policies on natural resource use and social wellbeing. Overview of existing natural resource policies with applications to forest and timber management, biodiversity, public lands, endangered species, and climate change mitigation and adaptation.
Prerequisite(s): NR 4014 or FREC 4424 or FOR 4424 or ECON 4014 or FREC 4014 or FOR 4014
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4444 - Integrated Forest Management Practicum (3 credits)
Application of accumulated discipline-oriented knowledge and techniques to solve forest resource management problems as a member of a team. Forest resource management and planning, multiple-use concepts to solve forest management problems, design and implement field-based sampling protocol, develop an integrated forest management plan with logical and ethical recommendations based on analysis of sampled data. Pre: Senior standing.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

FREC 4454 - Urban and Community Forestry (3 credits)
Ecological, socioeconomic, and technical aspects of assessing, planning, managing, and conserving urban forests. Examination of historical and contemporary approaches to urban forestry in local, national, and international contexts. Contributions of trees and associated greenspaces to urban sustainability and community well-being. Roles of government, private industry, and community stakeholders in stewarding urban forests. Theory and practice of written and oral communication to effectively exchange ideas and information about urban forests with diverse audiences. Pre: Junior standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4464, WATR 4464

FREC 4514 - Forest and Tree Pest Management (3 credits)
Identification and ecology of biotic and abiotic influences on forest and landscape tree health. Developing a theoretical and practical understanding for diagnosing and managing pests and stresses of trees in both the forest and landscape setting. Insects and diseases that attack trees.
Prerequisite(s): FREC 3324 or FOR 3324 or HORT 3325 or HORT 3326
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

FREC 4554 - Creating the Ecological City (3 credits)
Multidisciplinary, team oriented, problem-solving approaches to creating cities that foster healthy interconnections between human and ecological systems. Analysis of problems from practical and ethical perspectives in the context of the diverse knowledge bases and values of decision-makers. Formation and utilization of integrated design teams to solve complex urban design and planning problems at a variety of scales. Senior standing.
Prerequisite(s): HORT 2134 or FREC 2134
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 6A Critique & Practice in Arts, 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BSE 4554, HORT 4554, LAR 4554, SPIA 4554

FREC 4714 - Harvesting Systems Evaluation (3 credits)
Principles and techniques for evaluating harvesting machines and systems design, application, productivity, and financial performance.
Prerequisite(s): FREC 3714
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4784 - Wetland Hydrology and Biogeochemistry (3 credits)
Water flows creating wetland hydrologic regime. Hydrologic controls on wetland processes. Linkages between hydrology and biogeochemical cycles. Carbon, nitrogen, phosphorus, and other element cycles within and across wetland boundaries. Field methods to assess hydrologic regime and biogeochemical cycles. Ecosystems services from hydrologic and biogeochemical processes. Applications of wetland hydrology and biogeochemistry in wetland restoration, delineation, and creation.
Instructional Contact Hours: (3 Lec, 3 Crd)

FREC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

FREC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (WATR)

WATR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2004 - Water, Environment, and Society (3 credits)
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 2004

WATR 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 3104 - Principles of Watershed Hydrology (3 credits)
Study of hydrology in watersheds. Qualitative and quantitative principles of physical hydrological processes governing the movement, storage, and transformation of water on the Earths surface as influenced by watershed characteristics, including human modifications. Pre: Junior Standing
Prerequisite(s): MATH 1026 or MATH 1226 or STAT 3005 or STAT 3604 or STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3104

WATR 3754 - Watersheds and Water Quality Monitoring (3 credits)
Delivery of water quality constituents from watersheds to water bodies (streams, lakes, and estuaries). Field monitoring methods to assess watershed drivers and how they affect water quality and aquatic ecosystem condition. Linkages among water quality, watershed characteristics, land use and management, and climate. Design of watershed monitoring programs to guide watershed management for protecting water quality and ecological condition of aquatic systems.
Prerequisite(s): (BIOL 1106 or BIOL 1006) and CHEM 1035 and FREC 2004 or (FOR 2004 or FREC 2114 or FOR 2114 or FREC 3314 or FOR 3314 or BIOL 2804 or ENSC 3604)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 3754

WATR 4244 - Hydroinformatics (3 credits)
Analysis and examination of hydrologic data using basic statistics and computer programming. Calculation and interpretation of flow frequency and duration, hydrologic analysis of geospatial digital terrain data, and implementation and analysis of simple hydrologic models. Advanced methods of temporal and spatial hydrologic data visualization using computer programming.
Prerequisite(s): FREC 3104 or WATR 3104 or FREC 1044
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 4244

WATR 4464 - Water Resources Policy and Economics (3 credits)
Economic theory and methods to explain water use decisions. Efficiency, equity, and ethical considerations in U.S. water policy. Analysis of water markets, climate change, and environmental flows from diverse stakeholder perspectives.
Prerequisite(s): AAEC 1005 or ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4464, FREC 4464

WATR 4614 - Watershed Assessment, Management, and Policy (2 credits)
Multidisciplinary perspectives of assessment, management and policy issues for protecting and improving watershed ecosystems. Topics include: monitoring and modeling approaches for assessment, risk-based watershed assessment geographic information systems for watershed analysis, decision support systems and computerized decision tools for watershed management, policy alternatives for watershed protection, urban watersheds, and current issues in watershed management. Pre: Two 4000 level courses in environmental/natural resource science, management, engineering, and/or policy in BSE, CEE, FOR, FREC, GEOL, LAR, CSES, ENT, BIOL, GEOG, AAEC, UAP or equivalent.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: ALS 4614

WATR 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

WATR 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Environmental Conservation & Society Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
FREC 2214	Introduction to Land and Field Measurements *	3
FREC 2314	Forest Biology and Dendrology *	2
FREC 2324	Dendrology Laboratory	1
FREC 2614	Human-Environment Systems *	3
FREC/NR 4004	Professional Skills in Natural Resources *	1
FREC/NR 4014	Natural Resources Economics *	3
FREC 4114	Information Technologies for Natural Resource Management *	3
FREC 4434	Natural Resource Policy *	3
Subtotal		19
Major Requirements		
FIW 2114	Principles of Fish and Wildlife Conservation	3
FIW 4464	Human Dimensions of Fisheries and Wildlife *	3
FREC 2004	Forest Ecosystems	3
or FREC 3314	Forest Ecology and Silvics	
FREC 3524	Environmental Interpretation (Pathways Concept 1 - Discourse - Advanced) *	3
FREC 3544	Outdoor Recreation Planning and Management *	3
Subtotal		15
Restricted Electives		
Business Restricted Electives		3
Environmental Education and Outreach Restricted Electives		3
Environmental Science Restricted Electives		6
Human Dimensions Restricted Electives		6
Role of Science in Society Restricted Elective		3
Subtotal		21
Track Areas with Remaining Required Electives		
Students **must** customize their curriculum to complete one of the following three tracks by selecting an additional 9 credits from one of the three sets of restricted electives outlined below (Note: 6 of the 9 credits must be 3000 level or above).		9
Recreation and Tourism Management Track		
Outdoor Recreation Management & Tourism Restricted Electives (9 hours)		
Environmental Education and Outreach Track		
Environmental Education & Outreach Restricted Electives (6 hours)		
Leadership & Sustainability in Natural Resources Restricted Electives (3 hours)		
Leadership and Sustainability Track		
Leadership & Sustainability in Natural Resources Restricted Electives (9 hours)		
Subtotal		9
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills	3
or ENGL 1105	First-Year Writing	
COMM 1016	Communication Skills *	3
or ENGL 1106	First-Year Writing	
Completion of FREC 3524 fulfills Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		
Pathways Concept 2 - Critical Thinking in the Humanities		
FREC/LAR/NR 2554	Leadership for Global Sustainability	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select one of the following:		3

COMM 1014	Introduction to Communication	
GEOG 1004	Introduction to Human Geography	
GEOG/NR 1115	Seeking Sustainability	
PSCI 1014	Introduction to United States Government and Politics	
PSCI/IS 1024	Comp Gov & Politics	
PSYC 1004	Introductory Psychology	
SOC 1004	Introductory Sociology	
SOC 1014	Introduction to Social Anthropology	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
MATH 1025	Elementary Calculus	3
STAT 3604	Statistics for Social Science *	3
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Free Electives		
Select free electives to total 120 credits.		14
Total Credits		**120**

Restricted Electives

Code	Title	Credits
Business Restricted Electives		
AAEC 2104	Personal Financial Planning	3
AAEC 3454	Small Business Management and Entrepreneurship *	3
ACIS 1004	Accounting Foundations	3
ACIS 2115	Principles of Accounting *	3
ENGL 4804	Grant Proposals and Reports *	3
FREC 4024	Forest Resources Management and Business *	3
MGT 2064	Foundations of Entrepreneurship	3
MGT 3304	Management Theory and Leadership Practice *	3
MGT 4334	Ethical Leadership and Corporate Social Responsibility *	3
MKTG 3104	Marketing Management *	3
SBIO 2614	Introduction to Forest Products Marketing	3
SBIO 3004	Sustainable Nature-Based Enterprises	3
SBIO 3464	Sustainable Operations Management *	3
Environmental Education & Outreach Restricted Electives		
ALCE 3004	Educational Programs in Agricultural and Life Sciences	3
ALCE 3624	Communicating Ag and Life Sciences in Writing *	3
ALCE 4004	Teaching Adults in Agriculture	2
ALCE 4014	Introduction to Cooperative Extension	3
ALCE 4034	Methods of Planning Education Programs for Agriculture *	3
ALCE 4304	Community Education and Development *	3
ALCE/EDCT 4884	Youth Program Management	3
CMST 3064	Persuasion *	3
HUM/RLCL 3204	Multicultural Communication	3
FREC 3574	Environmental Education Service Learning	3
PR 2044	Principles of Public Relations	3
TA 2024	Introduction to Acting	3
Environmental Science Restricted Electives		
BIOL 2504	General Zoology *	3
BIOL 2704	Evolutionary Biology *	3
BIOL 2804	Ecology *	3
BIOL 4004	Freshwater Ecology *	4
CSES 3114/ GEOS 3614	Soils *	3
ENSC 3134	Soils in the Landscape *	3
ENSC 3604	Fundamentals of Environmental Science *	3
FIW 2314	Wildlife Biology *	3
FIW 2324	Wildlife Field Biology	3
FIW 3514	Fisheries Techniques *	3
FIW 4214	Wildlife Field Techniques *	3
FIW 4314	Conservation of Biological Diversity *	4
FIW 4334	Mammalogy *	4
FIW 4414	Population Dynamics and Estimation *	3
FIW 4424	Ichthyology	4
FIW 4434	Wildlife Habitat Ecology and Management *	3
FIW 4534	Ecology and Management of Wetland Systems *	3
FIW 4614	Fish Ecology *	3
FIW 4624	Marine Ecology	3
FREC 2514	Wildland Fire: Ecology and Management *	3
FREC/HORT 3354	Trees in the Built Environment *	3
FREC 3364	Environmental Silviculture *	3
FREC 3714	Forest Harvesting *	3
FREC/CSES 4334	Principles and Practice of Agroforestry	3
FREC 4354	Forest Soil and Watershed Management *	3
FREC 4374	Forested Wetlands *	3
FREC 4414	Advanced Wildland Fire Management *	3
HORT/FREC 2134	Plants and Greenspaces in Urban Communities	3
SBIO/FREC 2784	Global Forest Sustainability	3
SPES 2244	World Crops: Food and Culture	3
Human Dimensions Restricted Electives		
AAEC 3314	Environmental Law	3
AAEC 3324	Environment and Sustainable Development Economics *	3
FREC 2124	Forests, Society & Climate	3
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework *	3
FREC 4454	Urban and Community Forestry	3

FREC/AAEC/ WATR 4464	Water Resources Policy and Economics *	3
GEOG 3104	Environmental Justice, Resources and Development	3
LAR 3044	Land Analysis and Site Planning	3
LAR 3264	People Community and Place	3
PHIL 2304	Global Ethics	3
PSCI 3214	Political Participation *	3
PSCI 3224	Public Opinion *	3
PSCI 3334	Judicial Process *	3
PSCI 3354	Constitutional Law: Structures and Relationships *	3
PSCI 3414/ UAP 3434	Public Administration *	3
PSCI 3424	State and Local Government *	3
PSCI 3554	Comparative Political Economy *	3
PSCI/UAP 3744	Public Policy Analysis *	3
REAL 4754	Real Estate Law *	3
SOC 2004	Social Problems	3
SOC 3004	Social Inequality *	3
SOC 3204	Social Research Methods *	4
SOC 3504	Population Trends and Issues *	3
SPIA 2554	Collaborative Policy-Making and Planning	3
SPIA 3704	Urban Contention and Mobilization	3
UAP 3014	Urban Policy and Planning *	3
UAP/IS/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4264	Environmental Ethics and Policy	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy *	3
Leadership & Sustainability Restricted Electives (only 3 credits may be below 2000-level)		
ALCE 3014	Leadership Effectiveness for Professionals in Agricultural Organizations *	3
GEOG/NR 1116	Seeking Sustainability *	3
GEOG 4444	Practicing Sustainability *	3
GEOG/SPIA 2244	Sustainable Urbanization	3
LDRS 1414	Citizen Leadership	3
LDRS 3104	The Dynamics of Leadership *	3
LDRS 3304	Elements of Team Leadership *	3
NR 4105	Leadership in Natural Resources *	3
NR 4106	Leadership in Natural Resources *	3
SBIO 3004	Sustainable Nature-Based Enterprises	3
SBIO 3454	Society, Sustainability Biomaterials and Energy	3
UAP 1024	Leadership, Service, and Public Problem Solving	3
UAP 4394	Community Renewable Energy Systems	3
Outdoor Recreation & Tourism Management Restricted Electives		
HNFE 2274	Wilderness First Responder	3
HTM 2454	Global Travel & Tourism Management	3
HTM 2464	Designing the Service Experience	3
HTM 3424	Event Management *	3
HTM 3484	Socio-Cultural Impacts of Tourism	3
HTM 4354	Information Technology and Social Media in Hospitality and Tourism *	3
HTM 4444	Winery Tourism *	3
HTM 4484	International Tourism *	3
Study Abroad	Any study abroad course focusing on human-environment interactions	3-6
Role of Science in Society		
HIST/STS 3706	History of Science	3
PHIL 2605	Reason and Revolution in Science	3
PHIL 2606	Reason and Revolution in Science	3
RLCL/STS 2464	Religion and Science	3
STS 1504	Introduction to Science, Technology, and Society	3
STS 2154	The Life Sciences and Society	3
STS 2454	Science, Techology, and Environment	3
STS 3104	Science and Technology in Modern Society	3
STS 3334	Energy and Society	3

* Some courses may have prerequisites, corequisites, or other registration restrictions. Please consult the University course catalog for more information.

Satisfactory Progress: By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in Forest Resources and Environmental Conservation will include the following minimum criteria:

- Having an in-major and overall grade point average of at least 2.0
- Passing at least 24 semester credits that apply to Pathways requirements
- Passing the following courses or their equivalents: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology and MATH 1025 Elementary Calculus

Graduation Requirements

Environmental Conservation & Society Notes

1. **Minimum credit hours required for graduation is 120.**
2. An in-major and overall GPA of 2.0 is required for graduation.
3. **In-major GPA Computation:** Includes all courses designated as FIW, FREC, GEOG, NR, and SBIO.
4. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways requirements).
5. **Prerequisites:** Some courses must be taken in sequence to satisfy prerequisites. Check prerequisites for each course carefully as these are determined by each department individually. Consult with the University Course Catalog, Timetable of Classes, and your advisor.
6. **Policy on Student Exchanges:** If studying overseas or at another U.S. university, begin planning at least 9 months prior to your departure to allow time to determine what substitutions, if any, will be allowed and to arrange your schedule to ensure that all requirements for graduation will be met.

Acceptable Substitutions

- STAT 3604 Statistics for Social Science or STAT 3615 Biological Statistics: STAT 3005 Statistical Methods
- MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

Foreign Language Requirement

Foreign Language Requirement: A sequence of two (2) foreign language courses is required for graduation unless two (2) high school credits of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements."

Environmental Data Science Major

Program Curriculum

Code	Title	Credits
Minimum credit hours required for graduation is 120.		
Degree Core Requirements (19 credits)		
FREC 2214	Introduction to Land and Field Measurements	3
FREC 2314	Forest Biology and Dendrology	2
FREC 2324	Dendrology Laboratory	1
FREC 2614	Human-Environment Systems	3
FREC/NR 4004	Professional Skills in Natural Resources	1
FREC/NR 4014	Natural Resources Economics	3
FREC 4114	Information Technologies for Natural Resource Management	3
FREC 4434	Natural Resource Policy	3
Subtotal		19
Environmental Data Science Major Requirements		
Computational Requirements		
BIT 3424	Introduction to Business Analytics Modeling	3
BIT 3514	Systems Analysis	3
BIT 3524	Database Management and Design	3
FREC 1044	Introduction to Environmental Data Science	3
FREC 3044	Environmental Data Science	3
FREC 4044	Environmental Data Science Capstone	3
FREC 4214	Forest Photogrammetry and Spatial Data Processing	3
Select one of the following:		3-4
FREC 4244	Hydroinformatics	
FREC 3214 & FREC 3224	Forest Biometrics and Forest Measurements Field Laboratory	
Subtotal		24-25
Computer Programming Requirement		
Select one of the following:		3
CS 1044	Introduction to Programming in C	
or CS 1064	Introduction to Programming in Python	
or CS 1114	Introduction to Software Design	
Advanced Data Science Skills Requirement		
Select one of the following:		3
STAT 3616	Biological Statistics	
or MATH 2114	Introduction to Linear Algebra	
or CS 2064	Intermediate Programming in Python	
Natural Science Requirements		
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1116	Principles of Biology Laboratory	1
FREC 2004	Forest Ecosystems	3
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills (1F)	3
or ENGL 1105	First-Year Writing	
COMM 1016	Communication Skills (1F)	3
or ENGL 1106	First-Year Writing	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
Select three additional credits		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3-4
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus (5F)	3-4
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States [1]		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45-47
Free Electives		
Select additional credit hours to total at least 120		21
Total Credits		**120-123**

[1] Some courses have prerequisite or enrollment restrictions. Consult the undergraduate course catalog or the timetable of classes for more information.

Environmental Data Science Notes

1. **Satisfactory Progress:** By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in Forest Resources

and Environmental Conservation will include the following minimum criteria:

- Having an in-major and overall grade point average (GPA) of at least 2.0.
- Passing at least 24 semester credits that apply to Pathways for General Education
- Passing the following courses, or their equivalents: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology and BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory; MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable.

Graduation Requirements

1. **Degree Requirements:** An in-major and overall GPA of 2.0 is required for graduation.
2. **Minimum hours for degree is 120.**
3. In accordance with university guidelines, courses stratifying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways requirements).
4. **Policy on Student Exchange:** If studying overseas or at another U.S. university, begin planning at least 9 months prior to your departure to allow time to determine what substitutions, if any, will be allowed and to arrange your schedule to ensure that all requirements for graduation will be met.
5. **In-major GPA Computation:** All degree core and Environmental Data Science major requirements will factor into the in-major GPA.
6. **Curriculum Planning:** Students should plan early with their advisors to determine appropriate sequences for their courses. Some courses must be taken in sequence to satisfy prerequisites.

Acceptable Substitutions

1. STAT 3615 Biological Statistics: STAT 3005 Statistical Methods
2. BIOL 1105 Principles of Biology: CHEM 1035 General Chemistry
3. BIOL 1115 Principles of Biology Laboratory: CHEM 1045 General Chemistry Laboratory

Foreign Language Requirement

Foreign Language Requirement: A sequence of two (2) foreign language courses is required for graduation unless two (2) high school credits of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements."

Note: Students do not need to follow this plan exactly. This is an example plan.

First Year		
Fall Semester		**Credits**
COMM 1015 or ENGL 1105	Communication Skills (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) or First-Year Writing	3
BIOL 1105	Principles of Biology (Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	3
BIOL 1115	Principles of Biology Laboratory	1
MATH 1025 or MATH 1225	Elementary Calculus (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)) [1] or Calculus of a Single Variable	3
FREC 1044	Introduction to Environmental Data Science	3
Pathways Core Concept (example: Pathways 2 Course)		3
	Credits	**16**
Spring Semester		
COMM 1016 or ENGL 1106	Communication Skills (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)) or First-Year Writing	3
BIOL 1106	Principles of Biology (Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	3
BIOL 1116	Principles of Biology Laboratory	1
MATH 1026 or MATH 1226	Elementary Calculus (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)) or Calculus of a Single Variable	3
CS 1064 or CS 1114 or CS 1044	Introduction to Programming in Python [2] or Introduction to Software Design or Introduction to Programming in C	3
Free Electives		3
	Credits	**16**
Second Year		
Fall Semester		
FREC 2214	Introduction to Land and Field Measurements	3
FREC 2314	Forest Biology and Dendrology	2
FREC 2324	Dendrology Laboratory	1
Pathways Core Concept (example: Pathways 2 Course)		3
Pathways Core Concept (example: Pathways 3 Course)		3
Free Electives		3
	Credits	**15**
Spring Semester		
FREC 2004	Forest Ecosystems	3
FREC 2614	Human-Environment Systems	3
AAEC 1005 or ECON 2005	Economics of the Food and Fiber System (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)) or Principles of Economics	3
Pathways Core Concept (example: Pathways 7 Course)		3
STAT 3615	Biological Statistics (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
	Credits	**15**
Third Year		
Fall Semester		
FREC 4114	Information Technologies for Natural Resource Management	3
FREC 4004	Professional Skills in Natural Resources	1
BIT 3424	Introduction to Business Analytics Modeling [3]	3
STAT 3616 or MATH 2114 or CS 2064	Biological Statistics or Introduction to Linear Algebra or Intermediate Programming in Python	3
Free Electives		3
	Credits	**13**
Spring Semester		
FREC 3044	Environmental Data Science	3
FREC 4214	Forest Photogrammetry and Spatial Data Processing	3
BIT 3514	Systems Analysis	3
Pathways Core Concept (example: Pathways Concept 6D Course)		3
Free Electives		3
	Credits	**15**

Fourth Year		
Fall Semester		
FREC 4014	Natural Resources Economics	3
Pathways Core Concept (example: Pathways Concept 1A Course)		3
BIT 3524	Database Management and Design	3
Free Electives		3
Free Electives		3
	Credits	**15**
Spring Semester		
FREC 4434	Natural Resource Policy	3
FREC 4044	Environmental Data Science Capstone	3
Students may choose FREC 4244 or FREC 3214 . If student chooses FREC 3214, FREC 3224 must be taken as well.		
FREC 4244 or FREC 3214	Hydroinformatics or Forest Biometrics	3
Pathways Core Concept (example: Pathways Concept 6A Course)		3
Free Electives		3
	Credits	**15**
	Total Credits	**120**

New Footnote

1 Students planning to take MATH 2114 must select MATH 1225.

2 Students planning to take CS 2064 must select CS 1064.

3 EDS students must force-add BIT 3424; consult with advisor about prerequisites and force-add procedure.

Environmental Resources Management Major

Program Curriculum

Code	Title	Credits
Minimum credit hours required for graduation is 120. Prerequisites or enrollment restrictions may apply to some courses. Consult the undergraduate course catalog or the timetable of classes.		
Degree Core Requirements (19 credits)		
FREC 2214	Introduction to Land and Field Measurements [1]	3
FREC 2314	Forest Biology and Dendrology [1]	2
FREC 2324	Dendrology Laboratory	1
FREC 2614	Human-Environment Systems [1]	3
FREC/NR 4004	Professional Skills in Natural Resources	1
FREC/NR 4014	Natural Resources Economics [1]	3
FREC 4114	Information Technologies for Natural Resource Management [1]	3
FREC 4434	Natural Resource Policy [1]	3
Subtotal		19
Major Requirements (39 credits)		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
ENSC 3134	Soils in the Landscape	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FREC 2004	Forest Ecosystems [1]	3
or FREC 3314	Forest Ecology and Silvics	
FREC 2414	Field Experience in Forest Resources and Environmental Conservation	2
FREC/HORT 3354	Trees in the Built Environment	3
or FREC 4334	Principles and Practice of Agroforestry	
FREC 3364	Environmental Silviculture (Pathways 6 Design)	3
FREC 4214	Forest Photogrammetry and Spatial Data Processing [1]	3
or GEOG 4354	Introduction to Remote Sensing	
FREC 4354	Forest Soil and Watershed Management [1]	3
FREC 4374	Forested Wetlands [1]	3
FREC/AAEC/ WATR 4464	Water Resources Policy and Economics (Pathways 3 and 7) [1]	3
GEOS 1024	Earth Resources, Society, and Environment	3
or GEOS 1004	Earth Science: Our Past, Present, and Future	
GEOS 1124	Earth Resources, Society and Environment Laboratory	1
or GEOS 1104	Introduction to Earth Sciences Laboratory	
Subtotal		39
Restricted Electives (15 to 16 credits - see accompanying lists)		
Global Environmental Issues Restricted Elective		
Select one of the following:		3
AAEC 3204	International Agricultural Development and Trade (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)) [1]	
FREC 2124	Forests, Society & Climate (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) or Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	
FREC 4134	Forest Carbon Management and Policy	
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework	
GEOG 3104	Environmental Justice, Resources and Development (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03))	
GEOG 4204	Geography of Resources [1]	
GEOG/SOC/ UAP 4764	International Development Policy and Planning	
SBIO 2504	Circular Economy Analytics for Sustainable Systems	
UAP/PSCI 3344	Global Environmental Issues: Interdisciplinary Perspectives [1]	
UAP/GEOG/ WGS 4214	Gender, Environment, and International Development [1]	
Law Restricted Elective		
Select one of the following:		3
AAEC 3314	Environmental Law	
AAEC 3604	Agricultural Law	
FIN 3054	Legal and Ethical Environment of Business [1]	
UAP 4344	Law of Critical Environmental Areas	
UAP 4754	Legal Foundations of Planning [1]	
Public Relations Restricted Elective		
Select one of the following:		3
ENGL 4804	Grant Proposals and Reports [1]	

FREC 3524	Environmental Interpretation (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A))	
HUM/RLCL 3204	Multicultural Communication (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03))	
PR 2044	Principles of Public Relations	
SPIA 2554	Collaborative Policy-Making and Planning (Pathways Concept 3 - Reasoning in the Social Sciences Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States)	
Urban Environments Restricted Elective		
Select one of the following:		3
FREC/HORT 2134	Plants and Greenspaces in Urban Communities (Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	
FREC 4454	Urban and Community Forestry (Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A))	
GEOG 3244	The U.S. City [1]	
UAP 2014		
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 4374	Land Use and Environment: Planning and Policy [1]	
Water Restricted Elective		
Select one of the following:		3-4
BIOL 4004	Freshwater Ecology [1]	
BIOL/ENT 4354	Aquatic Entomology [1]	
FIW 4534	Ecology and Management of Wetland Systems [1]	
FIW 4614	Fish Ecology [1]	
FREC/WATR 3104	Principles of Watershed Hydrology [1,2]	
FREC/WATR 3754	Watersheds and Water Quality Monitoring [1]	
FREC 4784	Wetland Hydrology and Biogeochemistry	
Subtotal		15-16
Free Electives		
Select free electives to total 120 credits. [2]		2
Subtotal		2
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills	3
or ENGL 1105	First-Year Writing	
COMM 1016	Communication Skills	3
or ENGL 1106	First-Year Writing	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
FREC/LAR/NR 2554	Leadership for Global Sustainability	3
Select three credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		3
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
FREC/AAEC/WATR 4464	Water Resources Policy and Economics [1]	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus	3-4
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus	3-4
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics [1]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
FREC 3364	Environmental Silviculture [1]	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
FREC/AAEC/WATR 4464	Water Resources Policy and Economics	3
Subtotal		45-47
Total Credits		**120-123**

[1] Prerequisites or enrollment restrictions may apply to some courses. Some of the listed courses must be taken in sequence to satisfy prerequisites. Be sure to consult the University undergraduate course catalog, timetable of classes, or check with your advisor.

1. **Satisfactory Progress:** By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in Forest Resources and Environmental Conservation will include the following minimum criteria:
   - Having an in-major and overall grade point average of at least 2.0
   - Passing at least 24 semester credits that apply to Pathways General Education requirements
   - Passing the following courses or their equivalents: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, and BIOL 1116 Principles of Biology Laboratory; CHEM 1035 General Chemistry and MATH 1026 Elementary Calculus.

Graduation Requirements

Environmental Resource Management Notes

Minimum credit hours required for graduation is 120.

1. **In-major grade point average computation:** Includes all courses designated as FIW, FREC, GEOG, NR, SBIO, GEOS, and WATR.
2. An in-major and overall GPA of at least 2.0 is required for graduation.
3. In accordance with university guidelines, courses satisfying degree core requirements may not be double-counted to satisfy other areas of a degree (e.g., Pathways requirements) .
4. **Policy on Student Exchanges:** If studying overseas or at another U.S. university, begin planning at least 9 months prior to your departure to allow time to determine what substitutions, if any, will be allowed

and to arrange your schedule to ensure that all requirements for graduation will be met.

For students interested in pursuing hydrology positions in the federal government, please note:

US Office of Personnel Management: Hydrology Qualification Standards: Basic Requirements:
Degree: physical or natural science, or engineering that included at least 30 semester hours in any combination of courses in hydrology, the physical sciences, geophysics, chemistry, engineering science, soils, mathematics, aquatic biology, atmospheric science, meteorology, geology, oceanography, or the management or conservation of water resources. The course work must have included at least 6 [credit hours] in calculus (including both differential and integral calculus, e.g., MATH 1025 Elementary Calculus and MATH 1026 Elementary Calculus), and at least 6 [credit hours] in physics (e.g., PHYS 2205 General Physics and PHYS 2206 General Physics).
The Watershed Management minor will facilitate completion of additional water-related coursework that may be beneficial for those seeking federal hydrology positions. For full information, consult your advisor.

Acceptable Substitutions

1. **Acceptable Substitutions:** The following requirements have acceptable substitutions .
   - STAT 3615 Biological Statistics: STAT 3005 Statistical Methods
   - ENSC 3134 Soils in the Landscape : CSES 3114 Soils

Foreign Language Requirement

1. **Foreign Language Requirement:** A sequence of two (2) foreign language courses is required for graduation unless two (2) high school credits of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements."

Forestry Major

Code	Title	Credits
Degree Core Requirements		
FREC 2214	Introduction to Land and Field Measurements [1]	3
FREC 2314	Forest Biology and Dendrology [1]	2
FREC 2324	Dendrology Laboratory	1
FREC 2614	Human-Environment Systems [1]	3
FREC/NR 4004	Professional Skills in Natural Resources [1]	1
FREC/NR 4014	Natural Resources Economics [1]	3
FREC 4114	Information Technologies for Natural Resource Management [1]	3
FREC 4434	Natural Resource Policy [1]	3
Subtotal		19
Major Requirements		
ENSC 3134	Soils in the Landscape [1]	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FREC 2514	Wildland Fire: Ecology and Management [1]	3
FREC 3214	Forest Biometrics (Pathways Concept 5 - Quantitative and Computational Thinking)	3
FREC 3314	Forest Ecology and Silvics [1]	3
FREC 3724	Forest Boundaries and Roads [1]	3
FREC 4214	Forest Photogrammetry and Spatial Data Processing [1]	3
FREC 4514	Forest and Tree Pest Management [1]	3
Subtotal		24
Forestry Track Requirements		
Students must customize their curriculum to complete one of the following forestry major tracks by completing courses listed under their chosen track.		
Forest Resource Management Track		
Forest Operations and Business Track		
Urban and Community Track		
Subtotal		28-34
Free Electives		
Select additional credits to total 120 credits. (Students may need to complete less credit hours depending on choices in track and Pathways requirements.)		7-13
Subtotal		35-47
Pathways to General Education		
Pathways Concept 1 - Discourse		
COMM 1015	Communication Skills	3
or ENGL 1105	First-Year Writing	
COMM 1016	Communication Skills	3
or ENGL 1106	First-Year Writing	
Select one of the following:		3
FREC 3734	Forest Fiber Supply (Forest Resource Management Track, Forest Operations and Business Track) [1]	
FREC 4454	Urban and Community Forestry (Urban and Community Forestry Track) [1]	
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	3
or ECON 2005	Principles of Economics	
AAEC 1006	Economics of the Food and Fiber System	3
or ECON 2006	Principles of Economics	
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus	3-4
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus	3-4
or MATH 1226	Calculus of a Single Variable	
FREC 3214	Forest Biometrics (Pathways Concept 5 - Quantitative and Computational Thinking) [1]	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select one of the following:		3

FREC 4444	Integrated Forest Management Practicum (Forest Resource Mnagement Track, Forest Operations and Business Track)	
FREC 3364	Environmental Silviculture (Urban and Community Forestry Track) [1]	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [2]		3
Subtotal		42-44
Total Credits		**120-134**

[1] Prerequisites, corequisites, or other enrollment restrictions may apply to some courses. Consult the undergraduate course catalog or the timetable of classes for more information.

[2] A course taken to satisfy another Pathways concept that is listed with Pathways Concept 7 will satisfy Concept 7 requirements simultaneously.

Forest Resource Management Track

Code	Title	Credits
ACIS 1004	Accounting Foundations	3
or ACIS 2115	Principles of Accounting	
CHEM 1035	General Chemistry [1]	3
FREC 2414	Field Experience in Forest Resources and Environmental Conservation	2
FREC 3224	Forest Measurements Field Laboratory [1]	1
FREC 3324	Silviculture Principles and Applications [1]	4
FREC 3544	Outdoor Recreation Planning and Management [1]	3
or FREC 3354	Trees in the Built Environment	
FREC 3714	Forest Harvesting [1]	3
FREC 3734	Forest Fiber Supply (Pathways Concept 1 - Discourse) [1]	3
FREC 4354	Forest Soil and Watershed Management [1]	3
FREC 4444	Integrated Forest Management Practicum (Pathways 6 Design)	3
Subtotal		28
Free Electives		
Estimated free electives for Forest Resource Management Track [2]		11-13

[1] Prerequisites, corequisites, or other enrollment restrictions may apply to some courses. Consult the undergraduate course catalog or the timetable of classes for more information.

[2] Students complete free electives to reach the minimum 120 credits required for graduation. Free elective estimations are calculated utilizing available overlap between major/track requirements and Pathways requirements.

Forest Operations and Business Track

Code	Title	Credits
ACIS 1004	Accounting Foundations	3
or ACIS 2115	Principles of Accounting	
FREC 2414	Field Experience in Forest Resources and Environmental Conservation	2
FREC 3224	Forest Measurements Field Laboratory [1]	1
FREC 3324	Silviculture Principles and Applications [1]	4
FREC 3714	Forest Harvesting [1]	3
FREC 3734	Forest Fiber Supply (Pathways Concept 1 - Discourse) [1]	3
FREC 4444	Integrated Forest Management Practicum (Pathways Concept 6 - Critique and Practice in Design and the Arts)	3
FREC 4714	Harvesting Systems Evaluation [1]	3
Business Restricted Electives		
Select 12 credits from the following: (substitutions possible with approval)		12
AAEC 2104	Personal Financial Planning	
AAEC 3454	Small Business Management and Entrepreneurship	
AAEC 3504	Marketing Agricultural Products [1]	
AAEC 4424	Ag Financial Management [1]	
ACIS 2116	Principles of Accounting [1]	
ENGL 3764	Technical Writing [1]	
or ENGL 377	Business Writing	
FIN 2114	Investments and Financial Literacy	
FIN 3054	Legal and Ethical Environment of Business [1]	
FIN 3104	Introduction to Finance [1]	
FREC 4024	Forest Resources Management and Business [1]	
MGT 2064	Foundations of Entrepreneurship	
MGT 3304	Management Theory and Leadership Practice	
MKTG 3104	Marketing Management	
REAL 2004	Principles of Real Estate	
REAL 4064	Real Estate Appraisal	
REAL 4754	Real Estate Law [1]	
or AAEC 331	Environmental Law	
SBIO 2614	Introduction to Forest Products Marketing	
Subtotal		34
Free Electives		
Estimated free electives for Forest Operations and Business Track [2]		5-7

[1] Prerequisites, corequisites, or other enrollment restrictions may apply to some courses. Consult the undergraduate course catalog or the timetable of classes for more information.

[2] Students complete free electives to reach the minimum 120 credits required for graduation. Free elective estimations are calculated utilizing available overlap between major/track requirements and Pathways requirements.

Urban and Community Forestry Track

Code	Title	Credits
CHEM 1035	General Chemistry [1]	3
FREC 2254	Arboriculture Field Skills	1
or FREC 3454	Trees in the Built Environment Lab	
FREC 3354	Trees in the Built Environment	3
FREC 3364	Environmental Silviculture (Pathways Concept 6 - Critique and Practice in Design and the Arts) [1]	3
FREC 4454	Urban and Community Forestry (Pathways Concept 1 - Discourse) [1]	3

HORT 3325	Woody Landscape Plants	3
or HORT 3326	Woody Landscape Plants	
Applied Plant and Environmental Sciences Restricted Electives		
Select six credits from the following:		6
ENSC 4244	Ecological Restoration [1]	
ENT 4254	Insect Pest Management	
FREC 4354	Forest Soil and Watershed Management [1]	
HORT/FREC 2134	Plants and Greenspaces in Urban Communities	
LAR 1254	Environment and Natural Systems	
PPWS 2754	Weeds That Shape Our World [1]	
PPWS 4104	Plant Pathology [1]	
PPWS 4264	Pesticide Usage	
PPWS 4604	Biological Invasions [1]	
Policy, Planning, and Public Relations Restricted Electives		
Select six credits from the following:		6
AAEC 3314	Environmental Law	
FREC 3544	Outdoor Recreation Planning and Management [1]	
FREC/BSE/ LAR/HORT/ SPIA 4554	Creating the Ecological City	
GEOG 3244	The U.S. City [1]	
LAR 4034	Evolution of the American Landscape	
PR 2044	Principles of Public Relations	
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives [1]	
PSCI 3424	State and Local Government [1]	
PSCI 3434	Urban Politics [1]	
SPIA/GEOG 2244	Sustainable Urbanization	
SPIA 2554	Collaborative Policy-Making and Planning	
SPIA 4454	Future of Cities	
UAP 2014		
UAP 4344	Law of Critical Environmental Areas	
UAP 4374	Land Use and Environment: Planning and Policy [1]	
Subtotal		28
Free Electives		
Estimated Free Electives for Urban and Community Forestry Track [2]		10-12

[1] Prerequisites, corequisites, or other enrollment restrictions may apply to some courses. Consult the undergraduate course catalog or the timetable of classes for more information.

[2] Students complete free electives to reach the minimum 120 credits required for graduation. Free elective estimations are calculated utilizing available overlap between major/track requirements and Pathways requirements.

1. **Satisfactory Progress:** By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in Forest Resources and Environmental Conservation will include the following minimum criteria:
   - Having an in-major and overall grade point average of at least 2.0
   - Passing at least 24 semester credits that apply to the Pathways to General Education
   - Passing the following courses, or their equivalents: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, and MATH 1025 Elementary Calculus

Graduation Requirements

Minimum credit hours required for graduation is 120.

Forestry Notes

1. Policy on Student Exchanges: If studying overseas or at another U.S. university, begin planning at least 9 months prior to your departure to allow time to determine what substitutions, if any, will be allowed and to arrange your schedule to ensure that all requirements for graduation will be met.
2. In-major GPA Computation: Includes all courses designated as FREC.
3. An in-major and overall GPA average of 2.0 is required for graduation.
4. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g. Pathways to General Education).
5. Prerequisites: Some of the listed courses have prerequisites and some courses must be taken in sequence to satisfy prerequisites. Be sure to consult with the University Catalog or check with your advisor.

Acceptable Substitutions

1. **Acceptable Substitutions:** The following requirements have acceptable substitutions.
   a. ENSC 3134 Soils in the Landscape: CSES 3114 Soils

Foreign Language Requirement

Foreign Language Requirement: A sequence of two (2) foreign language courses is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements" .

Water: Resources, Policy, and Management Major

Code	Title	Credits
Degree Core Requirements (20 credits)		
ENSC 3604	Fundamentals of Environmental Science	3
PHYS 2205	General Physics	3
WATR/GEOG 2004	Water, Environment, and Society	3
WATR/FREC 3104	Principles of Watershed Hydrology	3
WATR/FREC 3754	Watersheds and Water Quality Monitoring	3
WATR/FREC/ AAEC 4464	Water Resources Policy and Economics	3
WATR/ALS 4614	Watershed Assessment, Management, and Policy	2
Subtotal		20

Major Requirements (42 credits)		
BIOL 1116	Principles of Biology Laboratory	1
CHEM 1045	General Chemistry Laboratory	1
GEOG 1524	Introduction to Earths Climate	3
GEOG/GEOS 4134	Interdisciplinary Issues and Ethics in Water Resources	3
PHYS 2215	General Physics Laboratory	1
WATR/FREC 4244	Hydroinformatics	3
Water Law and Planning requirement (3 credits - choose 1 course)		
AAEC 3314	Environmental Law	3
or UAP 3354	Introduction to Environmental Policy and Planning	
or UAP 4344	Law of Critical Environmental Areas	
or UAP 4374	Land Use and Environment: Planning and Policy	
Geospatial Technology requirement (3 credits - choose 1 course)		
FREC 4114	Information Technologies for Natural Resource Management	3
or FREC 4214	Forest Photogrammetry and Spatial Data Processing	
or GEOG 2084	Principles of Geographic Information Systems	
or GEOG 4354	Introduction to Remote Sensing	
Water Science and Water Policy Specializations:		
As part of the Major Requirements, students must complete both a Water Science and a Water Policy Specialization. For each section below, complete 12 credits. Choose 9 credits in one specialization area; for the remaining 3 credits, select any approved specialization course. See specialization course list attached.		
Water Science Specialization		
Select 9 credits in one of the three specializations areas below and an additional 3 credits from any Water Science course listed under specializations. (12 credits total)		*12*
I. Aquatic Ecosystems		
II. Hydrology		
III. Water Quality		
Water Policy Specialization		
Select 9 credits in one of the two specializations areas below and an additional 3 credits from any Water Policy course listed under specializations. (12 credits total)		*12*
I. Water Planning, Policy, and Economics		
II. Water, Climate, Energy, and Global Issues		
Restricted Electives		
Select 6 credits from courses listed under Water Science Specializations or Water Policy Specializations or from those listed as Restricted Electives.		6
Select remaining credits of Free Electives		7
Pathways Requirements (45 Pathways credits)		
1. Discourse (9 credits: 6 foundational credits, 3 applied/advanced)		*9*
Select 6 credits in Pathways Concept 1F - Discourse - Foundational		
Select 3 credits in Pathways Concept 1A - Discourse -Applied / Advanced; select one of the following:		
ENGL 2844	Introduction to Professional and Technical Writing	
or ENGL 3764	Technical Writing	
2. Critical Thinking in the Humanities (6 credits)		
Select six credits in Pathways Concept 2 - Critical Thinking in the Humanities		6
3. Reasoning in the Social Sciences (6 credits)		*6*
Select three credits in Pathways Concept 3 - Reasoning in the Social Sciences		
AAEC 1005	Economics of the Food and Fiber System	
or ECON 2005	Principles of Economics	
4. Reasoning in the Natural Sciences (6 credits)		*6*
BIOL 1106	Principles of Biology	
CHEM 1035	General Chemistry	
5. Quantitative and Computational Thinking (9 credits: 6 foundational credits, 3 applied/advanced credits) [1]		*9*
MATH 1025	Elementary Calculus	
or MATH 1225	Calculus of a Single Variable	
MATH 1026	Elementary Calculus	
or MATH 1226	Calculus of a Single Variable	
STAT 3615	Biological Statistics	
6. Critique and Practice in Design and the Arts (6 credits: 3 design & 3 arts, or 6 integrated)		
Select three credits in Pathway 6a and three credits in Pathway 6d		6
7. Critical Analysis of Identity and Equity in the United States (3 credits) - may be double counted with another core outcome or major requirement		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) *		3
Total Credits		**120**

* May be double-counted with another core outcome or major requirement

Water Science Specialization Courses

Aquatic Ecosystems

Code	Title	Credits
BIOL 4004	Freshwater Ecology	4
BIOL/ENSC 4164	Environmental Microbiology	3
BIOL/ENT 4354	Aquatic Entomology	4
ENT/BIOL/FIW 4484	Freshwater Biomonitoring	4
FIW 4534	Ecology and Management of Wetland Systems	3
FIW 4614	Fish Ecology	3
FREC 4374	Forested Wetlands	3

Hydrology

Code	Title	Credits
BSE 4224	Field Methods in Hydrology	3
CSES/GEOG/GEOS 3304	Geomorphology	3
CSES 3614	Soil Physical and Hydrological Properties	3
FREC 4354	Forest Soil and Watershed Management	3
GEOS 4804	Groundwater Hydrology	3

Water Quality

Code	Title	Credits
BSE 4394	Water Supply and Sanitation in Developing Countries	3
CEE 3104	Introduction to Environmental Engineering	3

BIOL/ENSC 4164	Environmental Microbiology	3
ENSC 3634	Physics of Pollution	3
ENSC/CHEM 4734	Environmental Soil Chemistry	3
ENSC 4314	Water Quality	3
FREC 4354	Forest Soil and Watershed Management	3
FREC 4374	Forested Wetlands	3
FREC 4784	Wetland Hydrology and Biogeochemistry	3
GEOS 4634	Environmental Geochemistry	3

Water Policy Specialization Courses

Water Planning, Policy, & Economics

Code	Title	Credits
AAEC 3004	Agricultural Production and Consumption Economics	3
AAEC 3314	Environmental Law	3
AAEC 3324	Environment and Sustainable Development Economics	3
AAEC 4314	Environmental Economic Analysis and Management	3
AAEC 4344	Sustainable Development Economics	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
CEE 4344	Water Resources Planning	3
FREC/NR 4014	Natural Resources Economics	3
FREC 4434	Natural Resource Policy	3
SPIA 2554	Collaborative Policy-Making and Planning	3
UAP 3354	Introduction to Environmental Policy and Planning	3
UAP 4344	Law of Critical Environmental Areas	3
UAP 4374	Land Use and Environment: Planning and Policy	3

Water, Climate, Energy, & Global Issues

Code	Title	Credits
BSE 4394	Water Supply and Sanitation in Developing Countries	3
CEE 4134	Environmental Sustainability - A Systems Approach	3
FREC 2004	Forest Ecosystems	3
FREC 2124	Forests, Society & Climate	3
FREC/IS/PSCI 4174	Climate Change and the International Policy Framework	3
GEOG 1514	Introduction to Meteorology	3
GEOG 3104	Environmental Justice, Resources and Development	3
GEOS 4314	Coastal Hazards	3
IS 4014	International Development	3
NR/GEOG 4444	Practicing Sustainability	3
PSCI/UAP 3344	Global Environmental Issues: Interdisciplinary Perspectives	3
UAP/GEOG/WGS 4214	Gender, Environment, and International Development	3
UAP/GEOG/SOC 4764	International Development Policy and Planning	3

Restricted Electives

Code	Title	Credits
AAEC 3604	Agricultural Law	3
ALS 3404	Ecological Agriculture: Theory and Practice	3
BIOL 1105	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory	1
BIOL 2604	General Microbiology	3
BIOL 2804	Ecology	3
BIOL 3204	Plant Taxonomy	3
BIOL 4014	Environmental Toxicology	2
BSE 2304	Landscape Measurements and Modeling	3
BSE 3324	Small Watershed Hydrology	3
BSE 3334	Nonpoint Source Pollution Assessment and Control	3
BSE 4304	Introduction to Watershed Modeling	3
CEE 3304	Fluid Mechanics for Civil and Environmental Engineering	4
CEE 3314	Water Resources Engineering	4
CEE 4104	Water and Wastewater Treatment Design	3
CEE 4304	Hydrology	3
CEE 4314	Groundwater Resources	3
CHEM 1036	General Chemistry	3
CHEM 1046	General Chemistry Laboratory	1
CHEM 2514	Survey of Organic Chemistry	3
CHEM 2535	Organic Chemistry	3
CSES 3114/ GEOS 3614	Soils	3
CSES 3124/ GEOS 3624	Soils Laboratory	1
CSES 4854	Wetland Soils and Mitigation	3
ECON 4014	Environmental Economics	3
ENSC 3134	Soils in the Landscape	3
ENSC 4244	Ecological Restoration	3
ENSC 4414	Monitoring and Analysis of the Environment	2
ESM 3024	Introduction to Fluid Mechanics	3
FIW 2114	Principles of Fish and Wildlife Conservation	3
FIW 4624	Marine Ecology	3
FREC Any 2000 - 4000 level FREC course		
GEOG 1104	Introduction to Environmental Geography	3
GEOG/NR 1115	Seeking Sustainability	3
GEOG/NR 1116	Seeking Sustainability	3
GEOG Any 2000 - 4000 level GEOG course		
GEOS 1004	Earth Science: Our Past, Present, and Future	3
GEOS 1024	Earth Resources, Society, and Environment	3
GEOS 1034	Earths Natural Hazards	3
GEOS 1104	Introduction to Earth Sciences Laboratory	1
GEOS 1124	Earth Resources, Society and Environment Laboratory	1
GEOS 2104	Elements of Geology	3
GEOS 3014	Environmental Geosciences	3
GEOS 3034	Oceanography	3
HIST 3144	American Environmental History	3

LAR 3154	Watershed Sensitive Site Design and Construction	4
MATH 2114	Introduction to Linear Algebra	3
MATH 2214	Introduction to Differential Equations	3
PHYS 2206	General Physics	3
PHYS 2216	General Physics Laboratory	1
PHYS 2305	Foundations of Physics	4
PSCI/UAP 3444	Administrative Law and Policy	3
PSCI/UAP 3714	The U. S. Policy Process	3
PSCI/UAP 3744	Public Policy Analysis	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
STAT 3006	Statistical Methods	3
STAT 3616	Biological Statistics	3
UAP 3014	Urban Policy and Planning	3
UAP 3024	Urban and Regional Analysis	3
UAP 4754	Legal Foundations of Planning	3

- **Satisfactory Progress:** By the end of the semester in which the student has attempted 60 credits (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in Water: Resources, Policy, and Management will include the following minimum criteria:
- Having an in-major and overall grade point average of at least 2.0
- Passing at least 24 semester credits that apply to Pathways Requirements
- Passing the following courses, or their equivalents: BIOL 1106 Principles of Biology, BIOL 1116 Principles of Biology Laboratory; CHEM 1035 General Chemistry, CHEM 1045 General Chemistry Laboratory; and MATH 1026 Elementary Calculus

Graduation Requirements

Minimum credits required for graduation is 120.

1. **Many of the courses have prerequisites, corequisites, or other registration restrictions. Please see the University Course Catalog for more information.**
2. **GPA for Graduation:** An in-major and overall GPA of 2.0 is required for graduation.
3. In accordance with university guidelines, courses satisfying degree core requirements may not be double counted to satisfy other areas of a degree (e.g., Pathways Requirements).
4. **American Institute of Hydrology - Educational Criteria:** This is an option for students interested in pursuing a Professional Hydrology certification with the American Institute of Hydrology after completing their B.S. and five years of experience. See American Institute of Hydrology Professional Hydrology Certification Application Process for specific requirements and for basic education requirements.

US Office of Personnel Management: Hydrology Qualification Standards:
Basic Requirements:
Degree: physical or natural science, or engineering that included at least 30 semester hours in any combination of courses in hydrology, the physical sciences, geophysics, chemistry, engineering science, soils, mathematics, aquatic biology, atmospheric science, meteorology, geology, oceanography, or the management or conservation of water resources. The course work must have included at least 6 semester hours in calculus (including both differential and integral calculus, e.g., MATH 1025 Elementary Calculus and MATH 1026 Elementary Calculus), and at least 6 semester hours in physics (e.g., PHYS 2205 General Physics and PHYS 2206 General Physics).

Notes:

1. Certain courses provide experiential learning opportunities as a significant component of the course (e.g., field labs, certifications, real-world data, computer programming, etc.). Courses with significant field components include ENT/BIOL/FIW 4484 Freshwater Biomonitoring, FREC 4374 Forested Wetlands, BSE 4224 Field Methods in Hydrology, CSES 3124 Soils Laboratory/GEOS 3624 Soils Laboratory. A course with a significant programming component is GEOG 4254 R Programming for Geospatial Applications. Courses with available certification: ENSC 4414 Monitoring and Analysis of the Environment (Optional 40-hour Hazardous Materials (HAZMAT) training available)."
2. **In-Major GPA Computation:** Degree core requirements and major requirements (with the exception of PHYS 2205 and Lab major requirements) count toward in-major GPA. This includes courses in the water science specialization and water policy specialization. For restricted electives and free electives, any course taken from either a water science specialization or a water policy specialization counts toward the in-major GPA.
3. **Policy on Student Exchanges:** If studying overseas or at another U.S. university, begin planning at least 9 months prior to your departure to allow time to determine what substitutions, if any, will be allowed and to arrange your schedule to ensure that all requirements for graduation will be met.

Acceptable Substitutions

Acceptable Substitutions: The following requirements have acceptable substitutions.

- PHYS 2205 General Physics/PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics
- CHEM 1035 General Chemistry/CHEM 1045 General Chemistry Laboratory: CHEM 1055 General Chemistry for Chemistry Majors
- STAT 3615 Biological Statistics /STAT 3005 Statistical Methods

Foreign Language Requirement

Foreign Language Requirement: Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six (6) semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

1. •

Geography

Our Website (http://www.geography.vt.edu)

Geography Degree Program

Geography offers a unique perspective on many of today's most important issues--from globalization, international development, and

culture change to environmental problems, population growth, and climate change. Its theories and methods provide analytical techniques applicable to a wide range of questions significant to a broad spectrum of occupations. The geography major provides a balance between an education focusing on contemporary social, political, economic, and environmental issues and training in advanced computer-based techniques.

Human geography is concerned with the spatial dimensions of human existence, the economy, politics, and culture as well as the relationshsips between humans and their environments.

Physical geographers study patterns of climate, landforms, vegetation, soils, water, and natural hazards and particularly the processes that produce those patterns, including human-environment interactions.

Geospatial science involves Geographic Information Systems (GIS), Global Positioning Systems (GPS), web services, and remote sensing. These technologies have led to significant advances in the ways in which geographic information is collected, mapped, analyzed, and integrated in database and decision-making systems. All students are exposed to these technologies as they are integral to working in the field today regardless of specialization and topic of interest.

Training in geography provides valuable, marketable skills that are in high demand in business, government, and education. Geography majors obtain employment in such diverse fields as geographic information systems, satellite imagery analysis, planning, transportation, market analysis, health care analysis, cartography (map making), land and water management, recreation, and environmental conservation. Our students and graduates have worked with county, state, and federal agencies, privte firms, non-profit organizations, and international organizations. Employment opportunities are especially strong for students obtaining advanced training in geospatial computer techniques, which are used by both human and physical geographers.

Geography Major Degree Requirements

The department offers courses in human geography, physical geography, and geospatial information science. In addition to fulfilling the requirements of the Pathways to General Education curriculum, geography majors must also complete 45 hours in geography and related disciplines. All must take GEOG 1004 Introduction to Human Geography, GEOG 1014 World Regions, GEOG 1084 Digital Planet, GEOG 1104 Introduction to Physical Geography, GEOG 2084 Principles of Geographic Information Systems, GEOG 2314 Maps and Mapping, GEOG 3314 Cartography and either STAT 3604 Statistics for Social Science or STAT 3615 Biological Statistics. Majors must also complete a field experience of at least 3 credit hours from GEOG 2964 Field Study, GEOG 2994 Undergraduate Research, GEOG 3954 Study Abroad, GEOG 4964 Field Study, or GEOG 4994 Undergraduate Research. Additionally, students must complete 18 credits of geography major courses and 3 credits from a cognate elective area. Students are directed to see the department's academic advisor and consult checksheets to confirm requirement for their graduation year. The Geography major leads to the B.A. in Geography degree.

The graduation requirements in effect during the academic year of admission to Virginia Tech apply. Requirements for graduation are listed on checksheets. Students must satisfactorily complete all requirements and university obligations for degree completion. The university reserves the right to modify requirements in a degree program.

Please visit the University Registrar's website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html for degree requirements.

Meteorology Degree Program

Meteorology is a science that analyzes conditions in the atmosphere and the impacts of weather and climate on the surface of the Earth. Importantly, meteorologists use specialized training to predict and forecast weather conditions and the potential ways humans may be affected by weather and climate, and then communicate that information to decision-makers and the general public.

Our meteorology program integrates geospatial science and climate science into the meteorology core coursework, which allows our graduates to work in the exciting nexus between the atmosphere and the ground beneath it. Today's meteorologists access a wide range of careers in society ranging from forecasting and reporting for multi-media, aiding industry in assessing severe weather impacts on business infrastructure and supply chains, blogging and software development, research, and forecasting for military or federal careers. Our students and graduates have worked with the National Weather Service (Blacksburg office and others), National Severe Storms Laboratory, the Weather Channel, as on-air television meteorologists, as officers with military appointments, and with government and private agencies.eorology degree and provides full credentials to work for the federal government as certified meteorologist.

Degree Requirements

As part of fulfilling the requirements of the Pathways to General Education, meteorology majors must MATH 1225 Calculus of a Single Variable and MATH 1226 Calculus of a Single Variable in addition to PHYS 2205 General Physics/PHYS 2215 General Physics Laboratory and PHYS 2206 General Physics/PHYS 2216 General Physics Laboratory or PHYS 2305 Foundations of Physics and PHYS 2306 Foundations of Physics. Meteorology majors must also complete 76 hours in geography/meteorology and related disciplines. All must take GEOG 1004 Introduction to Human Geography, GEOG 1014 World Regions, GEOG 1084 Digital Planet, GEOG 1104 Introduction to Physical Geography, GEOG 1504 Survey of Meteorology, GEOG 1514 Introduction to Meteorology, GEOG 2084 Principles of Geographic Information Systems, GEOG 2314 Maps and Mapping, GEOG 2505 Weather Analysis I, GEOG 2506 Weather Analysis II, GEOG 3314 Cartography, GEOG 3504 Severe Weather, GEOG 4084 Modeling with Geographic Information Systems, GEOG 4354 Introduction to Remote Sensing, and GEOG 4554 Remote Sensing of Atmosphere. All students must also -complete MATH 1114 or MATH 2114 Introduction to Linear Algebra, MATH 2214 Introduction to Differential Equations and STAT 3604 Statistics for Social Science or STAT 3615 Biological Statistics. Furthermore, all students are required to complete a field experience of at least 3 credit hours from MTRG 2964 Field Study, MTRG 3524 Meteorology Field Methods, MTRG 3954 Study Abroad, MTRG 4584 Topics in Applied Meteorology, or MTRG 4994 Undergraduate Research. Students must take three courses of restricted electives. Students are directed to see the department's academic advisor and consult checksheets to confirm requirements for their graduation year. The Meteorology major leads to the B.S. in Meteorology degree and provides full credentials to work for the federal government as a certified meteorologist.

Minors Offered

The following minors are offered:

- Geography Minor
- Geographic Information Science Minor
- Meteorology Minor
- Pathways to Sustainability Minor (transdisciplinary, includes courses in other departments)

Checksheets with program requirements can be found on the Office of the University Registrar's website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html

- Geography Major (p. 1206)
- Meteorology Major (p. 1208)

Head: T.W. Crawford
Professors: A.W. Ellis, L.W. Carstensen, K.N. Kolivras, and L.M. Resler
Associate Professors: T.D. Baird, L. Juran, L. M. Kennedy, R.D. Oliver, T. Pingel, and Y. Shao
Assistant Professors: A. Bukvic, Y., E. Galappaththi, J. Kim, C. Ramseyer, S. Zick
Collegiate Assistant Professor: S. Rijal
Instructors: J. D. Boyer, D. F. Carroll, S. Scales, and K. Stiles
Undergraduate Academic Advisor: J. Burger
Professor Emeritus: J.B. Campbell

Undergraduate Course Descriptions (GEOG)

GEOG 1004 - Introduction to Human Geography (3 credits)
Introduction to geography as a social science. Development of a conceptual framework for studying and evaluating human-environment relationships. Through examination of selected regional and global issues and through exploring basic concepts like regions, place, location, human-environment interaction, movement, and accessibility, students will discover how power is spatially expressed and explore how culture shapes the production of space and vice versa. Students will also discover and describe how ethical issues manifest spatially.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1014 - World Regions (3 credits)
Human and physical patterns and characteristics of major regions of the world including political systems, religions, economies, and physical settings. Concepts and perspectives of geography as a social science; linkages and interdependence of nations and regions; analysis of media coverage of events or global issues; engagement with current and historical global affairs.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1024 - Survey of Geography (1 credit)
Foundations of geography and subdisciplines. Career pathways for geography-interested students in various workforce sectors and sub-disciplinary specialization areas, including physical geography, GIScience, and human geography. Introduction to campus academic and geography-related career resources to enhance the undergraduate experience. Professional goal reflection and development.
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 1084 - Digital Planet (3 credits)
Exploration of innovative geospatial technologies and their impact on the world around us, including how humans interact with the environment and each other. Roles of location-based services, global positioning systems, geographic information systems, remote sensing, virtual globes and web based mapping for environmental applications. Skills and techniques for spatial thinking and environmental decision-making. Ethical implications of the use of geospatial technologies, data, and computational approaches.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 1004

GEOG 1104 - Introduction to Physical Geography (3 credits)
Integrated study of major subsystems of the natural environment: the nature, distribution, and interrelationships of landforms, climate and vegetation.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1115 - Seeking Sustainability (3 credits)
1115: Strategies to promote sustainability through the identification, description, and analysis of the dominant interconnections within and between environmental, social, and economic systems across local to global scales. 1116: Perceptions of, conditions of, and strategies to analyze processes of change within complex systems, and promote sustainability across local to global scales.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 1115

GEOG 1116 - Seeking Sustainability (3 credits)
Prerequisite(s): GEOG 1115 or NR 1115
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 1116

GEOG 1504 - Survey of Meteorology (1 credit)
An introductory look into the world of meteorology, including the role of forecasters, broadcast meteorologists, current research, and the prediction and response to significant storm events.
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 1514 - Introduction to Meteorology (3 credits)
Foundational properties and processes of Earth's atmosphere. Governing radiative and thermodynamic atmospheric equations. Extratropical weather systems, thunderstorms, hurricanes, and tornadoes. Cultural and societal impacts of extreme weather and climate change. Using meteorological and atmospheric data to construct weather forecasts.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1524 - Introduction to Earths Climate (3 credits)
An introduction to Earths climate system, including the physical mechanisms responsible for the global climate as well as its spatial and temporal variation; composition and structure of the atmosphere, radiation budget and temperature, precipitation and hydrologic budget, atmosphere and oceanic circulation, weather systems, paleoclimate, future climate; synergistic human-climate relationships, including global warming, climate change.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2004 - Water, Environment, and Society (3 credits)
Introduction to the hydrologic cycle, water resources, and related environmental issues. Emphasis on ethics and relationships between human needs for and effects upon water including: water quality, water treatment, and wastewater treatment; water for health, energy, and food; water management, laws, economics, and conflict; hydrometeorological hazards and climate change; and potential solutions for these and other critical water issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: WATR 2004

GEOG 2014 - Health and Place: Introduction to Health Geography (3 credits)
A survey of the field of health and medical geography. A study of the underlying interconnected processes at global to local scales from ecological and social perspectives that explain geographic patterns related to health, disease, and access to healthcare. Analysis of spatial patterns depicted on maps and connection to explanatory processes related to environmental exposures, demographic change, and the intersection of power, culture, and identity. Development of health-related written and oral content for broad audiences. Assessment and critique of presentation of scientific findings in popular media.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2034 - Geography of Global Conflict (3 credits)
Geographical dimensions of global conflicts, international management of conflicts, conflicts of differences, historical, ideological, failed states and resources will be examined. Background to conflicts, current status of conflicts, different points of view in conflict. Topics in the course will change as the geography of global conflict changes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2034, PSCI 2034

GEOG 2054 - Introduction to World Politics (3 credits)
An introduction to the prevalent methods and theories in the study of world politics. Topics include: historical context of contemporary world politics, global actors and power relations, conflict and conflict resolution, international law, and contemporary global issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2054, PSCI 2054

GEOG 2064 - The Global Economy and World Politics (3 credits)
Introduction to theories and methods in the study of global political economy. Topics include: historical origins, comparative advantage, the factor endowment trade theory, the gold standard, economic nationalism, the Great Depression, the Bretton Woods System, Keynesianism, the Nixon shocks, international organizations, monetary governance, the Great Recession, poverty and underdevelopment, and contemporary challenges of income inequality within and among economies.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2064, PSCI 2064

GEOG 2074 - COVID-19: Global Pandemic, Local Impacts (3 credits)
Examination and analysis of COVID-19's diffusion through the population at multiple spatial scales, from global to individual, using theories and methods of social science and medical geography. Critical study of the pandemic as a biological and social phenomenon, place within its cultural, historical, economic, political, and geographic contexts. Development of persuasive logical arguments on COVID-related topics through analyzing country, US state, and local level impacts of the COVID pandemic. Critical analysis of responses to the COVID pandemic. Synthesis of interconnected variables that contribute to differential impacts of COVID on different population groups. Identification of factors that may contribute to future pandemics.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2084 - Principles of Geographic Information Systems (3 credits)
Principles and diverse applications of Geographic Information Systems, geographic coordinate systems, Cartesian map projections, spatial data sources, GIS databases, map representations, and illustrated spatial applications of GIS. Requires regular use of computer systems for geographic data analysis.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2104 - Introduction to Environmental Security (3 credits)
Environmental security concepts, issues, and terminology. Study of emerging issues at the nexus of environmental and climate change and security risks, including homeland, human, national, energy, food, and water securities. Overview of climate-driven conflicts, displacement and migration, and geopolitical instability. Policy and programmatic solutions. Assessment of case studies using methods such as strategy analysis, scenario development, and simulations.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2114 - Introduction to Coastal Regions (3 credits)
Introduction to coastal geomorphology (landforms and processes), climate drivers (sea level rise and storms surge), and natural systems that shape coastal regions. Study of human systems including population growth, built environment, and social vulnerability. Overview of coastal zone management and policy. Discussion of the future of coastlines shaped by complexity, emerging challenges, uncertainty, adaptation, and resilience.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2134 - Geography of the Global Economy (3 credits)
Geographical dimensions of the global economy since World War II. Globalization and the emergence of a new international division of labor. The relative decline of the United States and the growth of Japan, East Asia and the European Union. Changing geographies of foreign direct investment location. Places and regions in geo-economic discourse. Population and resources issues in the early twenty-first century.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2134, PSCI 2134

GEOG 2224 - Geography of Europe (3 credits)
Europe: as an idea, as a place, as a space, and as a political entity. Basic knowledge of Europe's historical physical environments, political geography, population distribution, varied cultures, and economic development. Cultural variations and their implications on settlement patterns, political divisions, and economic patterns and processes.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 2224, PSCI 2224

GEOG 2244 - Sustainable Urbanization (3 credits)
Process of urbanization and theories and approaches of urban development. Debates on the meanings of sustainable urbanization and development in cities and how they are measured. Urban sustainability initiatives in the context of urban political economies, land-use practices, urban inequality and diversity, urban nature, and urban policy and politics. Programs and policies designed to enhance sustainable urbanization. Comparative approach and global perspective. Fee $30.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SPIA 2244

GEOG 2314 - Maps and Mapping (3 credits)
Introduction to maps. Fundamentals of reading, analysis, and interpretation of hard copy and digital maps, as they are required to illuminate spatial problems. Influences of maps on attitudes toward and images of the geographic environment.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2505 - Weather Analysis I (3 credits)
Introduction to the operational tools and processes in weather forecasting. Surface data and upper-air sounding analysis, forces producing and directing wind flow, jetstreams, weather chart analysis, and atmospheric moisture including clouds and precipitation.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2506 - Weather Analysis II (3 credits)
Introduction to the operational tools and processes in weather forecasting. Numerical forecast modeling and current operational models, ensemble forecasting and model output statistics, structureand dynamics of fronts and mid-latitude cyclones, development of thunderstorms and tornadoes, and the use of Doppler radar and satellite imagery in short-term forecasting.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2784 - Geography of Tea (3 credits)
Physical and human geographic overview of tea. Biogeography, history, economics, and ceremonial practices of the worlds tea producing regions. Analysis of terroir and processing through tasting exercises and sensory evaluation. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 3034 - The CIA: Its Capabilities in Todays Geo-Political World (3 credits)
Role of the discipline of geography in the origins, procedures, and history of CIA. Role of the CIA in providing national intelligence at both strategic and operational levels. Origins and changes to the CIA since WWII. Capabilities to support both policy-makers and national security entities. Case studies illustrating the CIAs operations in different regions of the world.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3034, PSCI 3034

GEOG 3104 - Environmental Problems, Population, and Development (3 credits)
Environmental problems in their social, spatial, and global contexts. Impacts of globalization, neoliberalism, and population growth on the environment. Examination of effects of developed and developing countries on the environment. Focus on conceptualizing development, population dynamics, environmental justice, factory farming, energy and renewable energy, global health, disasters, and intercultural and global awareness.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3214 - Africa Together (3 credits)
Strategies to identify, discuss and apply theories of stereotyping, empathy, and scarcity in the context of contemporary Africa. Application of theories to compare and analyze examples of social networks, music, disease, and violence in Africa and the U.S. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3224 - Geography of Appalachia (3 credits)
Appalachia as a region: physical environment, development of internal settlement, cultural, and economic patterns. Human adaptations to environmental change, traditions, and connections to and from external regions.
Prerequisite(s): GEOG 1004 or GEOG 1104 or GEOG 1014 or APS 1704 or HUM 1704
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3234 - Geography of Virginia (3 credits)
Virginia as a region: its physical environment, settlement, cultural, economic, and political patterns. Human adaptation to environmental change, human modification of environments and linkages to external regions. Climate, Biogeography and Water, and Environmental Hazards related to Natural Resources. Pre: 3 credit hours of Geography.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3244 - The U.S. City (3 credits)
The economic, political, and social forces driving urbanization in the United States. The American city in historical context with particular emphasis on the rise of manufacturing, deindustrialization, and suburbanization. Case studies from the manufacturing and sunbelt regions to illuminate key constructs from urban and human geography. Border examples of comparative urbanization from the U.S. -Mexican border, the Caribbean, and Canada.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3254 - Geography of East Asia (3 credits)
A geographical analysis of several modern states in East Asia, specifically China, Japan and the Koreas. Economic, political, and cultural change since the end of World War II. Globalization and the emergence of the China as a demographic and economic giant.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3274 - Polar Environments (3 credits)
Introduction to polar regions emphasizing interdisciplinary concepts, a systems approach, and communication of polar science to non-scientific audiences. Developing and defending arguments on the global significance and geopolitics of polar regions. Feedbacks among biophysical and human processes and resources. Strategies to deliver effective oral presentations, and to defend arguments in writing and group debates on topics including multiculturalism, human-environmental interactions, and climate change impacts in polar regions. Foster understanding of indigenous worldviews using native narratives. Pre: Sophomore standing.
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3304, GEOS 3304

GEOG 3314 - Cartography (3 credits)
Science and art of cartography including the conceptual framework of the cartographic method. Development of the skills necessary to create maps to be used in the analysis of spatial phenomena. Emphasis on thematic and ethical cartography.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOG 3404 - Mountain Geography (3 credits)
Physical characteristics of mountains, such as steep slopes, climatic extremes, and sharp environmental gradients, and their influences on the ways in which people, animals, and plants interact. Physical processes that operate in high-relief environments, including consideration of climate, geomorphology and biogeography. Influence of physical processes in mountain environments on human culture and activities. Cultural significance of mountains. Mountains as a resource. Land use and human-land interactions in mountains. Course is intended for students with an interest in what makes mountains unique and inspiring landscape elements.
Prerequisite(s): GEOG 1104
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3464 - Appalachian Communities (3 credits)
The concept of community in Appalachia using an interdisciplinary approach and experiential learning. Interrelationships among geographically, culturally, and socially constituted communities, public policy, and human development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AHRM 3464, APS 3464, HD 3464, HUM 3464, SOC 3464, UAP 3464

GEOG 3504 - Severe Weather (3 credits)
An introduction into mesoscale environments favoring the development of severe thunderstorms and tornadoes, the analysis of moisture, instability and shear parameters associated with severe weather events. Thunderstorm life-cycles, analysis of thermodynamic diagrams, role of wind shear and associated convective mode, hail production and forecasting, tornadogenesis and research.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3515 - Dynamic Meteorology (3 credits)
Examination of the physics that govern motion of Earths atmosphere. General atmospheric concepts, atmospheric principles of thermodynamics, hydrostatics, and stability. 3516: Examination of the physics that govern motion of Earths atmosphere. Principles of fluid dynamics, specifically the physics governing horizontal motion, corresponding vertical motions, and synoptic scale systems, as represented in various coordinate systems.
Prerequisite(s): GEOG 2506 and MATH 2214 and (PHYS 2206 and PHYS 2216 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3516 - Dynamic Meteorology (3 credits)
3515: Examination of the physics that govern motion of Earths atmosphere. General atmospheric concepts, atmospheric principles of thermodynamics, hydrostatics, and stability. 3516: Examination of the physics that govern motion of Earths atmosphere. Principles of fluid dynamics, specifically the physics governing horizontal motion, corresponding vertical motions, and synoptic scale systems, as represented in various coordinate systems.
Prerequisite(s): GEOG 3515
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 3844 - European Geopolitics (3 credits)
Impact of Geography on European politics and economics. Significance of territorial, identity, networking and environmental geopolitics. Theoretical debates in the fields of political and population geography. Current culture and demographic challenges and geopolitical disputes within Europe and particularly between the European Union (EU) and its neighboring world regions.
Prerequisite(s): GEOG 2224 or IS 2224 or PSCI 2224
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3844, PSCI 3844

GEOG 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

GEOG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 18 credit hours

GEOG 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4044 - Biogeography (3 credits)
A survey of the field of biogeography. A study of the factors influencing the distribution of plants and animals approached from ecological, historical, and cultural perspectives. Human influence on biotic patterns, such as crop domestication, habitat alteration, species introductions and extinctions, management issues, and environmental change, is a primary focus.
Prerequisite(s): GEOG 1104 or BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4054 - Geography of Wine (3 credits)
Analysis of physical and cultural forces that shape the production, consumption, and great variety of wine in the world. Wine as a complex commodity is examined through its economic, social, political, and ideological impacts in different parts of the world throughout history. Particular emphasis will be focused on place as an agent in defining the product.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4074 - Medical Geography of Infectious Diseases (3 credits)
Examination of geographic patterns of infectious diseases and underlying explanatory processes at spatial scales ranging from global to local. Interactions between natural and social environments and their contributions to infectious disease burdens. Human health impacts of climate variability and change. Application of theories such as landscape epidemiology and methods in medical geography and the social sciences to understanding disease emergence events and pandemics. Examination of role of environmental change and human migration on disease diffusion patterns. Analysis of major factors related to HIV/AIDS epidemic that explain the disease's spatial and spatio-temporal pattern in different social and cultural settings. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4084 - Modeling with Geographic Information Systems (3 credits)
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Course Crosslist: GEOS 4084

GEOG 4094 - Generative AI Applications in Social Science (3 credits)
Apply key concepts in generative AI to social science research across multiple disciplines, including geography, urban studies and planning, environmental studies, education, writing, sociology, psychology, political science, and economics. Analyze quantitative and qualitative data by utilizing various generative AI tools, such as ChatGPT and Dall-E. Integrate the geographic information system (GIS) with generative AI tools. Evaluate the impacts of generative AI on society in terms of ethical concerns, geographic and sociodemographic biases, and responsible uses. Criticize existing generative AI tools. Develop public and educational policies to guide the responsible use of generative AI for social science research. Pre: Junior Standing
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4134 - Interdisciplinary Issues and Ethics in Water Resources (3 credits)
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOS 4134

GEOG 4164 - Qualitative Methods & Ethics in Geography (3 credits)
Overview of qualitative research methods in the context of human geography. Theories, practices, and interpretations surrounding human geography methods. Debates surrounding the use of a range of qualitative methods. Critical analysis of academic writing. Data collection, analysis and interpretation methods. Epistemological underpinnings of qualitative methodological choices. Ethical considerations related to human subject research. Visual, graphic, and oral communication skills. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4184 - Health Applications of Geospatial Techniques (3 credits)
Investigation of theoretical foundations and practical uses of geospatial techniques in the analysis of human health data. Emphasis on description of spatial data and measurement of clustering of diseases and health concerns. Quantification of exposure to pathogens and environmental factors that impact human health to explain clusters. Analysis of health disparities and their impact on health. Acquisition and analysis of health data, interpretation of findings, and presentation of results in independent analysis. Development of policies to promote population health.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4204 - Geography of Resources (3 credits)
Physical and cultural systems that influence the spatial distribution of resources and resource use. Emphasis on historical and current contexts of natural resources use and perspectives in the United States, with consideration of worldwide distributions of resources. Environmental cognition and perception, water, public lands, conservation and preservation, food and hunger, human population, and alternative energy. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4214 - Gender, Environment, and International Development (3 credits)
Key concepts and critiques related to the intersection of gender, environment, and international development. Development institutions and organizations with relationship to gender and environment. Theoretical and applied perspectives on eco-feminism; bio-diversity; climate change; feminist political ecology; agriculture and natural resources; participatory methods and empowerment. Case studies from Africa, Asia, and Latin America. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: UAP 4214, WGS 4214

GEOG 4224 - Tracking Environmental Change (3 credits)
Multidisciplinary approaches to documenting and understanding past environmental change. Methods used to unravel the physical and human drivers of historical and longer-term changes in climate, vegetation, and fire patterns. Application of environmental change data and insights to improve land and conservation management under changing climates. Pre: Junior standing
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4254 - R Programming for Geospatial Applications (3 credits)
Geospatial data analytics using R programming language. Batch-processing capability for analyzing large vector and raster geospatial data including remote sensing imagery and GIS layers. Using R scripts, algorithms, and functions to implement spatial analysis and spatial-temporal modeling. Bridging open source GIS/remote sensing and Machine learning. Linux system and high-performance computing environment.
Prerequisite(s): GEOG 4084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4284 - Human Dimensions of Coastal Social-Ecological Systems (3 credits)
Coastal change and multiple stressors. Social-ecological systems. Concepts of resilience, vulnerability and adaptation to climate change. The tragedy of the coastal commons. Adaptive management, co-management, adaptive co-management. Non-Western knowledge systems, Indigenous and local knowledge. Food security, blue food systems, food system transformations. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4304 - Geospatial Analysis of Mobility (3 credits)
Apply key concepts in human mobility and travel behavior theories to real-world scenarios. Analyze emerging issues in mobility and its impacts on society, encompassing topics such as ride-hailing services, autonomous vehicles, AI, and smart city technologies, and evaluate their implications for future urban development. Evaluate and implement R- and Python-based geospatial analysis tools to address contemporary mobility issues. Synthesize and analyze big geospatial and human mobility data. Propose innovative policy and urban planning recommendations.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4314 - Spatial Analysis in Geographic Information Systems (3 credits)
Theory and application of Geographic Information Systems, with special emphasis on analytical operations, database design, cartographic modeling, and raster GIS. Spatial data handling and analysis to facilitate decision-making through the communication of geographically referenced data.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOG 4324 - Algotrithms in Geographic Information Systems (4 credits)
Computational methods in automated mapping and map analysis. Visual Basic programming and algorithm design for spatial display and analysis under both raster and vector data models. Requires regular use of the departmental microcomputer and UNIX workstation laboratory.
Prerequisite(s): GEOG 4084 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOG 4334 - Geospatial Information Technology for Land Change Modeling (3 credits)
Analysis of the spatio-temporal patterns of Land Use and Land Cover Change (LULCC) as observed in satellite images. Tropical deforestation, urbanization, and agricultural intensification. Rates and patterns of LULCC linked to biophysical and socio-economic drivers. Impacts of land change with respect to local climate, biodiversity, water yield and quality, and ecosystem services.
Prerequisite(s): GEOG 4084 or GEOS 4084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4354 - Introduction to Remote Sensing (3 credits)
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar, and thermal infrared imagery. Digital analysis, image classification, and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOS 4354

GEOG 4374 - Remote Sensing and Phenology (3 credits)
Analysis of spatial and temporal patterns of the vegetated land surface as observed by satellite images. Application of satellite image time series to derivation of land surface phenology, and analysis of the appearance and development of phenology in the USA and worldwide. Methods of monitoring of phenology with satellite imagery. Causes of spatio-temporal changes of phenological events. Effects of global climate change.
Prerequisite(s): GEOG 4354
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4394 - Introduction to Web Mapping (3 credits)
Application of web mapping technologies to geographic data collection, storage, analysis, and display. History and context, spatial data infrastructures, hardware and software architectures, open geospatial consortium standards, mapping APIs, virtual globes, user-centric design, web cartography. Group and individual projects.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4404 - Geovisualization (3 credits)
Advanced topics in digital and dynamic map production, emphasizing concepts in advanced cartographic design, information visualization, and human-computer interaction. Topics include cartograms, computer aided design, animation, lidar and photogrammetric point cloud visualization, Web Geographic Information Systems, terrain visualization, and virtual geographic environments.
Prerequisite(s): GEOG 2084 and GEOG 3314
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4414 - Climate Change and Societal Impacts (3 credits)
Impacts of climate change on different societies. Concepts of adaptation, vulnerability, and resilience. Notions of complexity, uncertainty, and thresholds related to climate change outcomes. Case study analysis of communities affected by climate change. Understanding future and assessing climate vulnerability across various spatiotemporal scales. Scenario planning, foresight analysis, and interactive digital tools. Pre: Sophomore standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4444 - Practicing Sustainability (3 credits)
Practicum in sustainability. Synthesize and integrate knowledge from undergraduate career and apply to real world problems of sustainability. Topics and projects selected from opportunities to examine specific local and regional sustainability issues on the VT campus, in the New River Valley and the Commonwealth at large. Pre: Senior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NR 4444

GEOG 4504 - Synoptic Meteorology (3 credits)
Examination of large-scale (1000-5000km) weather systems using both analytical and operational analysis. Topics include thermal structure of atmosphere & resulting circulation, frontal analysis, lifting mechanisms, barotropic/baroclinic systems, and mid-latitude cyclones. Weather pattern influences of the jetstreams and oscillation of large pressure systems including El Nino/La Nina and the North Atlantic Oscillation.
Prerequisite(s): GEOG 3504 and MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4514 - Tropical Meteorology (3 credits)
Tropical weather and climate topics: remote sensing and observations; tropical climatology, including regional and large-scale circulations, monsoons, and the El Nino/Southern Oscillation; tropical convection, including the clouds in the subtropics, deep convection in the equatorial region, and tropical cloud clusters and thunderstorms; and tropical cyclones, including their structure, intensity, lifecycle, and formation.
Prerequisite(s): GEOG 2506 and GEOG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4524 - Physical Meteorology (3 credits)
Study of the physics associated with cloud and precipitation development, the emission, absorption, and transmission of solar and terrestrial radiation, meteorological acoustics, and atmospheric electricity.
Prerequisite(s): GEOG 3515
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4534 - Numerical Weather Prediction (3 credits)
Scientific basis of numerical weather prediction, including data assimilation, numerical integration, model initialization, physical parameterizations, ensemble methods, and model verification. Overview of numerical errors and their effects on predictability. Current operational forecasting models and the role of models in weather forecasting. Application of knowledge to running a high-resolution numerical weather forecast in a high-performance computing environment.
Prerequisite(s): GEOG 3515 and GEOG 4504
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4554 - Remote Sensing of Atmosphere (1 credit)
Remote sensing technologies used in monitoring weather. Evaluation of Doppler radar products, including base reflectivity, base velocity, storm-relative velocity, and vertically integrated liquid imagery. Could observation through infrared and visible satellite imagery; remote weather station design, set-up and data retrieval.
Prerequisite(s): GEOG 4354
Instructional Contact Hours: (1 Lec, 1 Crd)

GEOG 4574 - Climate Data Analysis and Programming (3 credits)
Elements of 1-dimensional and high-dimensional climate data storage and formatting. Manipulate and query atmospheric reanalysis, global climate model, and gridded observation datasets. Implement efficient research workflows through the development of computer scripts to statistically analyze climate data.
Prerequisite(s): GEOG 2505
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOG 4764 - International Development Policy and Planning (3 credits)
Examination of major development theories and contemporary issues and characteristics of low-income societies (industrialization, urbanization, migration, rural poverty, hunger, foreign trade, and debt) that establish contexts for development planning and policy-making. Junior standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SOC 4764, UAP 4764

GEOG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Undergraduate Course Descriptions (MTRG)

MTRG 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 3524 - Meteorology Field Methods (3 credits)
A field methods course in meteorology. On-location observation and analysis of temperature, wind fields, pressure, and dewpoint. In-field experiences with radar and satellite data, numerical model output and portable weather stations. On-location sites and corresponding curriculum may include severe storm analysis in the Great Plains, mountain weather in the White Mountains (NH) or Rocky Mountains (CO), and costal storms along the Atlantic or Gulf of Mexico coastlines. May be repeated for credit, with permission and different content, for a maximum of 9 hours.
Prerequisite(s): GEOG 2506 and GEOG 3504
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

MTRG 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4584 - Topics in Applied Meteorology (1-3 credits)
Contemporary and emerging theory and praxis in meteorology. Variable topics such as operational weather forecasting situations and scenarios. Identifying common meterological problems and developing pragmatic approaches for solutions. Repeatable with different content for a maximum of six credit hours.
Prerequisite(s): GEOG 1514
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 6 credit hours

MTRG 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MTRG 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Geography Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOG 1004	Introduction to Human Geography	3
GEOG 1014	World Regions	3

GEOG 1084/ FREC 1004	Digital Planet	3
GEOG 1104	Introduction to Environmental Geography	3
GEOG 2084	Principles of Geographic Information Systems	3
GEOG 2314	Maps and Mapping	3
GEOG Field Experience [1]		*3*
Select one of the following:		
XXXX 3954	Study Abroad	
GEOG 4964	Field Study	
GEOG 4994	Undergraduate Research	
Subtotal		21
Major Requirements		
GEOG 3314	Cartography	3
Select 18 credits from the following:		18
GEOG/NR 1115	Seeking Sustainability	
GEOG/NR 1116	Seeking Sustainability	
GEOG 1514	Introduction to Meteorology	
GEOG 1524	Introduction to Earths Climate	
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 2014	Health and Place: Introduction to Health Geography	
GEOG 2034	Geography of Global Conflict	
GEOG 2054	Introduction to World Politics	
GEOG/PSCI/IS 2064	The Global Economy and World Politics	
GEOG 2104	Introduction to Environmental Security	
GEOG 2114	Introduction to Coastal Regions	
GEOG 2244	Sustainable Urbanization	
GEOG 2505	Weather Analysis I	
GEOG 2784	Geography of Tea	
GEOG 3034	The CIA: Its Capabilities in Todays Geo-Political World	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 3224	Geography of Appalachia	
GEOG 3234	Geography of Virginia	
GEOG 3244	The U.S. City	
GEOG 3254	Geography of East Asia	
GEOG 3274	Polar Environments	
GEOG 3304	Geomorphology	
GEOG 3404	Mountain Geography	
GEOG/AHRM/ APS/HD/ HUM/SOC/ UAP 3464	Appalachian Communities	
GEOG 4044	Biogeography	
GEOG 4054	Geography of Wine	
GEOG 4074	Medical Geography of Infectious Diseases	
GEOG 4084	Modeling with Geographic Information Systems	
GEOG 4134	Interdisciplinary Issues and Ethics in Water Resources	
GEOG 4204	Geography of Resources	
GEOG 4214	Gender, Environment, and International Development	
GEOG 4224	Tracking Environmental Change	
GEOG 4354	Introduction to Remote Sensing	
GEOG 4414	Climate Change and Societal Impacts	
GEOG 4764	International Development Policy and Planning	
Subtotal		21
Cognate Elective		
Select one of the following:		3
FREC 2114	Ecology of Appalachian Forests	
FREC 2124	Forests, Society & Climate	
FREC/HORT 2134	Plants and Greenspaces in Urban Communities	
FREC/NR/LAR 2554	Leadership for Global Sustainability	
FREC 3044	Environmental Data Science	
FREC/PSCI/IS 4174	Climate Change and the International Policy Framework	
GEOS 1034	Earths Natural Hazards	
GEOS 3014	Environmental Geosciences	
GEOS 3034	Oceanography	
SBIO/FREC 2784	Global Forest Sustainability	
SBIO 3004	Sustainable Nature-Based Enterprises	
SBIO 3324	Green Building Systems	
SOC 1014	Introduction to Social Anthropology	
SOC/HIST/ STS 2604	Introduction to Data in Social Context	
SOC 3204	Social Research Methods	
STAT 3616	Biological Statistics	
Subtotal		3
Free Electives		
Select credits to total 120 credit hours		28
Subtotal		28
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits of lecture in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Select two credits of lab in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		2

Pathways Concept 5 - Quantitative and Computational Thinking		
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) (GEOG majors may not use GEOG 1084 in this area)		6-8
Select two of the following:		
CS 1014	Introduction to Computational Thinking	
MATH 1014	Precalculus with Transcendental Functions	
MATH 1025	Elementary Calculus	
MATH 1026	Elementary Calculus	
MATH 1225	Calculus of a Single Variable	
MATH 1226	Calculus of a Single Variable	
STAT 3604	Statistics for Social Science	3
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
GEOG 3314	Cartography	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47-49
Total Credits		**120-122**

By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.A. or B.S. degree in the College of Natural Resources and Environment will include the following minimum criteria: having an in-major and overall grade point average of at least 2.0 and passing at least 24 semester credits that apply to the Pathways to General Education.

Graduation Requirements

1. **Geography Field Experience** must be relevant to major and approved by the Department and College.
2. **Prerequisites**: Some of the listed courses have prerequisites and enrollment restrictions. Some courses must be taken in sequence to satisfy prerequisites. Be sure to consult with the University Catalog, Timetable of Classes, or check with your advisor.
3. **In-major GPA Computation:** Includes all courses designated as GEOG, an in-major and overall GPA average of 2.0 is required for graduation.
4. **Meteorology Double Major:** Geography students planning to double major in Meteorology must complete 15 additional credits: at least 12 hours of GEOG coursework that is not being used to complete either major; and two distinct (3 credits each) field experiences that apply to each major.
5. **Pathways to General Education:** Courses used to satisfy Pathways requirements cannot be double counted to also satisfy degree core requirements. However, Pathways courses may be double counted to satisfy other program area credit hour requirements.

Foreign Language Requirement

A sequence of two (2) foreign language courses is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements."

Meteorology Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOG 1104	Introduction to Environmental Geography	3
GEOG 1084	Digital Planet	3
GEOG 1504	Survey of Meteorology	1
GEOG 1514	Introduction to Meteorology	3
GEOG 2314	Maps and Mapping	3
GEOG 2505	Weather Analysis I	3
GEOG 2506	Weather Analysis II [1]	3
GEOG 3504	Severe Weather [1]	3
Subtotal		22
Major Requirements		
Meteorology		
GEOG 3515	Dynamic Meteorology [1]	3
GEOG 3516	Dynamic Meteorology [1]	3
GEOG 4504	Synoptic Meteorology [1]	3
GEOG 4524	Physical Meteorology [1]	3
Mapping and GIS		
GEOG 2084	Principles of Geographic Information Systems	3
GEOG 3314	Cartography	3
GEOG/GEOS 4084	Modeling with Geographic Information Systems [1]	3
GEOG/GEOS 4354	Introduction to Remote Sensing	3
GEOG 4554	Remote Sensing of Atmosphere [1]	1
Math and Statistics		
MATH 2214	Introduction to Differential Equations [1]	3
STAT 3604	Statistics for Social Science [1]	3
or STAT 3615	Biological Statistics	
Human Systems		
GEOG 1004	Introduction to Human Geography	3
GEOG 1014	World Regions	3
Select one of the following:		3
GEOG/NR 1115	Seeking Sustainability	
GEOG/WATR 2004	Water, Environment, and Society	
GEOG 2114	Introduction to Coastal Regions	
GEOG/IS/PSCI 2134	Geography of the Global Economy	
GEOG 3104	Environmental Justice, Resources and Development	
GEOG 3224	Geography of Appalachia [1]	
GEOG 3244	The U.S. City [1]	
GEOG 4054	Geography of Wine	
GEOG 4074	Medical Geography of Infectious Diseases [1]	
GEOG 4414	Climate Change and Societal Impacts	

GEOG 4134	Interdisciplinary Issues and Ethics in Water Resources	
GEOG 4204	Geography of Resources [1]	
JMC 3184	Media Weather Reporting	
Field Experience		
Select one of the following: [2]		3
MTRG 3524	Meteorology Field Methods (Field Methods topics may vary)	
MTRG 4584	Topics in Applied Meteorology	
MTRG 4994	Undergraduate Research	
Subtotal		43
Restricted Electives		
Select three of the following: [3]		9
CHEM 1015	Chemistry in Context	
CHEM 1016	Chemistry in Context	
CHEM 1035	General Chemistry [4]	
CHEM 1036	General Chemistry [1,4]	
CS 1014	Introduction to Computational Thinking	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python [4]	
CS 1114	Introduction to Software Design	
CS 2114	Software Design and Data Structures [1]	
MATH 2204	Introduction to Multivariable Calculus [1,4]	
FREC 3104	Principles of Watershed Hydrology [1,4]	
FREC 3604	[1]	
GEOG 1524	Introduction to Earths Climate	
GEOG 3274	Polar Environments	
GEOG 3304	Geomorphology [1]	
GEOG 3404	Mountain Geography [1]	
GEOG 4044	Biogeography [1]	
GEOG 4224	Tracking Environmental Change	
GEOG 4514	Tropical Meteorology [1,4]	
GEOG 4534	Numerical Weather Prediction	
GEOG 4574	Climate Data Analysis and Programming [4]	
GEOS 1064	Climate History: Past, Present, and Future	
GEOS 3034	Oceanography [4]	
GEOS 4804	Groundwater Hydrology [4]	
STAT 3616	Biological Statistics [1,4]	
Subtotal		9
Free Electives		
Select remaining credit hours to fulfill remaining credits required for graduation.		12
Subtotal		12
Pathways to General Education [5]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F) [1]	3
or COMM 1016	Communication Skills	
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
The meteorology major covers this area with completion of GEOG 1004 and 1014.		
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics [1]	4
PHYS 2306	Foundations of Physics [1,6]	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F) [1]	4
Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) filled with STAT 3604 or STAT 3615		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D) filled with GEOG 3314		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [6]		
Subtotal		34
Total Credits		**120**

1. **Prerequisites or enrollment restrictions** may apply to some courses.
2. **In-major GPA Computation:** Includes all courses designated as GEOG/MTRG, an in-major and overall GPA average of 2.0 Is required for graduation.
3. **Geography Double Major:** Meteorology students planning to double major In Geography must complete 15 additional credits: at least 12 hours of GEOG course work that Is not being used to complete either major; and two distinct (3 credits each) field experiences that apply to each major.
4. Students **interested in graduate school or NWS/NOAA employmen**t should consider these courses.
5. **Pathways General Education:** Courses used to satisfy Pathways General Education requirements cannot be double counted to also satisfy degree core requirements. However, Pathways courses may be double counted to satisfy other program area credit hour requirements.
6. **PHYS 2306 restriction**: MATH 1226 is a required co-requisite for PHYS 2306. Students must be enrolled in both courses through Virginia Tech. MATH 1226 transfer credit enrollment will be accepted only as a prerequisite for PHYS 2306, not a corequisite.

By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree In the College of Natural Resources and Environment will Include the following minimum criteria: having an In-major and overall grade point average of at least 2.0 and passing at least 24 semester credits that apply to the Pathways to General Education, and students must have completed 15 hours in Geography/Meteorology.

Graduation Requirements

In-major GPA Computation: Includes all courses designated as GEOG/MTRG, an in-major and overall GPA average of 2.0 Is required for graduation.

Required minimum hours in major: 76 hours

Required minimum hours for the degree: 120 hours

Foreign Language Requirement

A sequence of two (2) foreign language courses Is required for graduation unless two (2) high school units of the same foreign language or six (6) transfer credit hours of foreign language have been earned. These credits do not count toward graduation. See catalog section on "Graduation Requirements."

Sustainable Biomaterials

Our Website (http://www.sbio.vt.edu)

Packaging Systems and Design

Learn how sustainable packaging is used to eliminate waste and pollution in the environment, how packaging design enhances products, and how smart materials are used in food and drug packaging to enhance safety and quality.

Sustainable Biomaterials

Apply the STEM disciplines to natural renewable materials to help us develop our sustainable future. Learn how biomaterials can be made and utilized in ways to produce better performing materials with less environmental impact. Study options include sustainable residential structures, creating sustainable society, biomaterials science, and forest products business.

Sustainable Biomaterials Minor and Packaging Science Minor

Minors are offered for students interested in obtaining knowledge and skills in the wood science field to supplement their primary major field of study.

- Packaging Systems and Design Major (p. 1215)
- Sustainable Biomaterials Major (p. 1216)

Head: C-H. M. Huang
Professors: B.H. Bond, U.K. Buehlmann, R.J. Bush, K.J. Edgar, C.E. Frazier, A.L. Hammett, C-H. M. Huang, D.E. Kline, J.R. Loferski, H.J. Quesada, R.L. Smith, P.M. Winistorfer, and A. Zink-Sharp
Associate Professors: D.P. Hindman, L. Horvath, Y. Kim and M. Roman
Assistant Professors: J.D. Russell
Professor Emeritus: F.M. Lamb, W.G. Glasser, M.S. White

Undergraduate Course Descriptions (SBIO)

SBIO 1004 - Explorations in Sustainable Biomaterials (1 credit)
Topics and related career paths in Sustainable Biomaterials. Resources promoting academic success, personal improvement, and professional development. Problem solving, inquiry, teamwork, and oral, written, and visual communication applied to sustainable biomaterials issues.
Instructional Contact Hours: (1 Lec, 1 Crd)

SBIO 1014 - Introduction to Packaging Systems and Design (1 credit)
Information and skills necessary to succeed in the Packaging Systems and Design program; use of the library resources and use of intellectual property of others; laboratory reports, presentation skills, safe laboratory practices, and resume and packaging career portfolio.
Instructional Contact Hours: (1 Lec, 1 Crd)

SBIO 1024 - Systems Thinking in a Bioeconomy (3 credits)
Fundamental principles of a systems-thinking approach in evaluating complex systems related to a bioeconomy, which includes continued use and reuse of materials, chemical, and energy derived from natural materials within both industrial and natural environments. Systems mindset and frameworks, methodologies, and tools to contribute to discussions on solving complex problems integrating interconnected social, economic, and environmental factors while considering ethics. Case study-based approach to analyze and assess the impacts of conventional and alternative solutions to real-world challenges.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 1114 - A Sustainable Future through Circular Economy (3 credits)
Concepts, principles, and frameworks to understand sustainable production and consumption systems. Critical exploration of the six "R's": Reduce, Reuse, Repair, Refurbish, Remanufacture, and Recycle. Circular economy models for technical and bio-based materials to enable sustainable design. Special emphasis on systems-thinking methods for evaluating alternative/circular system design for sustainable biomaterials. Elements of sustainable biomaterial products and business models that optimize material efficiency and value-retention. Current initiatives by industry and governments to implement sustainable production and consumption practices and policies around the world.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 1234 - Introduction to Wood, Design and Craftmanship (3 credits)
Wood as a material. Introduction to laboratory techniques, wood processing, machining and woodworking, moisture interactions, species characteristics, microscopic techniques, measuring material properties, characteristics of forest products industry, career opportunities.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2004 - Computer-Aided Design in Packaging (3 credits)
Principles of Computer-Aided Design (CAD) in the packaging industry. Basics of virtual primary package development, computer-aided design of the secondary package, computer-aided optimization of truck loading and palletization. Development of a comprehensive packaging system in a virtual environment.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2104 - Principles of Packaging (3 credits)
History of packaging, structure of packaging industry, careers in packaging, packaging functions, materials and material properties, prototyping and manufacturing methods, packaging forms and types, distribution packaging, printing and decorating, packaging laws and regulations, sustainability issues, packaging design process.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2124 - Structure and Properties of Sustainable Biomaterials (3 credits)
Macroscopic and microscopic structure and chemical composition of wood and other biomaterials such as grasses, bamboo, and bagasse. Relationships between anatomical structure and physical/mechanical behavior. Microscopic identification of commercially important biomaterials. Preparation and analysis of microscope slides and scanning electron micrographs.
Prerequisite(s): BIOL 1105 and CHEM 1035
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2154 - Packaging and Culture (3 credits)
Explore packaging as a fundamental component of human culture. Survey the historical evolution of packaging as material culture and its influence across various domains using fundamental concepts such as cultural diffusion, functionalism, and systems thinking. Topics including the pivotal role of packaging in the transition to agriculture, significance in early legal systems, establishment of weights and measures, contributions to the development of global trade networks, and implications for food security, social institutions, and international conflicts. Identify interconnections in raw material access and cultural factors that influence packaging design, economic systems, trade and world views. Relationship between packaging and human health, equity, and the environment. Historical lessons will be used to analyze contemporary issues and emerging trends to forecast their potential societal impacts.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2214 - Design Fundamentals for Packaging (3 credits)
Introduction to the foundation of packaging design, visual elements, design principles, and Adobe Illustrator. Basic studio workshop with focuses on packaging design processes, two-dimensional graphic work, and package design projects. Aesthetic judgment and critical thinking skills through practice in packaging design projects and critique. Design Lab/Studio. Course FEE $46.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 2224 - Materials and Manufacturing Technology: from Nature to Innovation (3 credits)
Properties and characteristics of biomaterials (mechanical, chemical, thermal, etc.) that influence their production, application, value stream, and sustainability. Case-based approach to assessment and evaluation of basic manufacturing processes and the biomaterials used to make products. Perspectives on how manufacturing infrastructures and economies evolved based on the discovery of materials, from pre-industrial biological and nature-based systems to advanced technical materials used today. Manufacturing technology trends and how they are shaping economic, societal, and environmental impacts in biomaterials and related manufacturing technologies and packaging innovation.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2314 - Building Information Modeling for Wood-Based Construction (3 credits)
Building information modeling (BIM), computer-aided design (CAD) and the role of BIM and CAD in wood construction. Use of BIM and CAD to improve construction efficiency. Study of REVIT use including building layout, family editor, detailing, schedules, material lists and 3-dimensional rendering. Discussion of construction documentation and plan reading. BIM methods and tools in the design and detailing of residential light-frame, mass timber, and historic buildings.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2504 - Circular Economy Analytics for Sustainable Systems (3 credits)
Concepts, principles, and framework to understand systems level interactions in linear (cradle-to-grave) and circular (cradle-to-cradle) processes. Problem solving application and practice utilizing computational tools and data analytics. Special emphasis on quantifying and evaluating life-cycle circularity of common products and processes used to meet societys demand. Evaluation of case study results towards the planning of more circular business models in a complex global economy. Risks and ethical issues associated with decision making and policy based on results from computational models. Pre: Precalculus with Transcendental Functions (3 credits)
Prerequisite(s): MATH 1014 or MATH 1025 or MATH 1225 or MATH 1524 or MATH 1535 or MATH 1525
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 2514 - Introduction to Sustainability and Industrial Ecology (3 credits)
Explore fundamental sustainability concepts and industrial ecology principles, navigate the intricate interactions between natural and industrial environments. Discover how nature-based design and innovation inform industrial practices in food, water, transportation, and energy systems and contribute to more sustainable futures. Apply methodologies like Material Flow Analysis, Life Cycle Analysis, and handprint analysis to create decision-making tools for broadening positive impacts. Use data collection, analytics, and accounting techniques to assess conventional and nature-based industrial system performance. Develop innovative solutions to real-world sustainable challenges such as climate resilience, sustained food production, and improved well-being.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2614 - Introduction to Forest Products Marketing (3 credits)
Study of marketing systems and methods used by North American primary and secondary forest product industries. Emphasis on wood product industries. Marketing of hardwood lumber, softwood lumber, panels, composites, furniture, and paper products. Role of North American industries and markets in world trade of forest products.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 2784 - Global Forest Sustainability (3 credits)
A socio-economic approach to examining the management and use of the worlds forests, enhance knowledge of global forest resources and products, and understand the roles and relationships of key stakeholders.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: FREC 2784

SBIO 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3004 - Sustainable Nature-Based Enterprises (3 credits)
Planning for green and sustainability values for profit and non-profit enterprises that produce and market nature-based products and services (e.g., wood products, wildlife, fish, ecotourism). Understanding current green business environments to foster natural resource-based enterprises.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3005 - Sustainable Packaging Design and Innovation (3 credits)
3005: Principles of sustainability, laboratory packaging evaluation including testing procedures, simulation of physical hazards. Professional communications including laboratory reports and oral presentations. Development of comprehensive packaging evaluation plans. Evaluation of existing packaging systems and improving them from the sustainability perspective. 3006: Application of project management to the packing development process. Apply lean management principles to packing design process. Design of sustainable packaging solutions through industry sponsored projects.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3006 - Sustainable Packaging Design and Innovation (3 credits)
3005: Principles of sustainability, laboratory packaging evaluation including testing procedures, simulation of physical hazards. Professional communications including laboratory reports and oral presentations. Development of comprehensive packaging evaluation plans. Evaluation of existing packaging systems and improving them from the sustainability perspective. 3006: Application of project management to the packing development process. Apply lean management principles to packing design process. Design of sustainable packaging solutions through industry sponsored projects.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3014 - Life Cycle Assessment Field Course (1 credit)
Cultivate hands-on experience in defining the scope and system boundaries of life cycle assessment (LCA) to collect data for computational LCA work. Apply the step-by-step LCA methodology to real-world problems to develop a streamlined LCA impact assessment and interpret the results in simple language for discussions with stakeholders. Use feedback from stakeholder discussions to discover how to improve the LCA assessment process. Each class will concentrate on specific types of LCA applications, namely Social LCA, Economic LCA (e.g., Life Cycle Costing), or Environmental LCA (e.g., water or carbon footprinting). Students will have an opportunity to apply their LCA work across selected sectors such as manufacturing, transportation, agricultural and/or forestry, and energy. This course may be repeated two times with different content for a maximum of 3 credit hours.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

SBIO 3104 - Packaging Design Applications (3 credits)
Design structure of packaging with Adobe Photoshop, Adobe Illustrator, and Esko. Lab course adapting typography, illustration, and photography to create packaging prototypes. Structural integrity and display ethics through practice in packaging design projects and research. Identify the product target market. Design/Lab Studio. Course FEE $78.
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 3124 - Paper and Paperboard Packaging (3 credits)
Paper and paperboard properties and types. Types and performance of flexible paper packaging, sacks, and wraps. Folding carton design, properties of corrugated fiberboard. Corrugated fiberboard container design and performance. Packaging regulations and hazards of the distribution environment. Printing, labeling and automatic identification methods.
Prerequisite(s): SBIO 2104
Corequisite(s): SBIO 2004
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3224 - Packaging Distribution Systems (3 credits)
Unit load and parcel supply chains. Principles of operation and design of warehouse distribution and fulfillment centers. Principles of operation and design of shipping and distribution systems. The relation between packaging design, pallet design, and unit load design and the operation of industrial consumer goods supply chain.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3244 - Packaging Machinery and Production Systems (3 credits)
Selection of machinery systems to form, fill and seal packaging operations for multiple package and material categories; analysis of the effect of packaging design and material selection on production efficiency and manufacturing capacity; statistical process control for packaging systems; packaging line design.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3264 - Packaging Supply Chain (3 credits)
Supply chain strategies for packaging. Principles for planning and control of inventory, emphasis on dependent demand and material requirement planning for packaging materials in consumer-packaged goods companies; analysis and management of packaging components procurement, and supply contracts in a globalized environment; financial aspects of logistics and supply chain operations; logistics for returnable packaging containers.
Prerequisite(s): SBIO 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3284 - Packaging Polymers and Production (3 credits)
Introduction to synthetic, natural and sustainable polymer science and engineering as applied to packaging systems. Morphology, rheology, physical and thermal properties, processing methods, and polymerization of traditional, natural and sustainable packaging polymers. Detailed study of relationships among materials, processing, and structural properties through hands-on experience. Both traditional and advanced industrial mass production technology, and global regulation and environmental impact of packaging articles.
Prerequisite(s): SBIO 2104
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 3314 - Mechanics of Sustainable Biomaterials and Packaging (4 credits)
Mechanical properties of sustainable biomaterials and packaging materials including concepts of stress, strain, Poissons ratio, orthotropic properties, tension, compression, bending and effects of moisture on mechanical properties. Current issues related to sustainable biomaterial and packaging material use in industry. Standard methods of evaluating important mechanical properties of solid wood, composites, packaging, paperboard and fiber.
Prerequisite(s): PHYS 2205 or PHYS 2305
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SBIO 3324 - Green Building Systems (3 credits)
Definition of green buildings with specific focus on wood frame single family housing and appropriate green building systems. Site specification, resource efficiency, water efficiency, indoor environmental quality, homeowner education and global impact. Certification in various green building systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3334 - Survey of Non-timber Forest Products (3 credits)
In depth study of non-timber forest products of NTFP throughout Appalachia with overseas example - their heritage, uses and markets, economic development opportunities, and sustainable management. Emphasis will be placed on utilization and management issues. Students will gain skills necessary to assess and plan for NTFP business opportunities.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3434 - Chemistry and Conversion of Sustainable Biomaterials (3 credits)
Chemical composition of plant matter. Chemistry and biosynthesis of plant components. Cellulosic biofuel technology. Industrial conversion of woody biomass: pulping, bleaching, papermaking. Industrial conversion of cellulose by chemical processes.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3444 - Sustainable Biomaterials and Bioenergy (3 credits)
Introduction to the structure and properties of natural composites, biobased polymers, and naturally-derived chemicals for materials and energy applications. Chemistry of biomass deconstruction. Industrial applications of biobased polymers, monomers, and chemicals.
Prerequisite(s): (CHEM 2514 or CHEM 2535) and (CHEM 3615 or CHEM 4615)
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3445 - Entrepreneurial Wood Design and Innovation (3 credits)
Concept to market business project applied to design and innovation of wood products. Product design based on consumer need and sustainable use of natural resources. Writing a business plan including, product innovation, resource sustainability, marketing, strategic planning, production planning, technology utilized, packaging and distribution to final market.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3446 - Entrepreneurial Wood Design and Innovation (3 credits)
Students run teams and experiential learning to organize and deploy the project according to a business plan, measure key performance areas, and manage the quality of the product and process value streams necessary to sustain a profitable business.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3454 - Society, Sustainability Biomaterials and Energy (3 credits)
Sustainability, raw materials and energy needs of society. Use of sustainable biomaterials to meet societys needs and reduce impact on the environment. Methods to evaluate and certify the sustainability of materials and consumer goods. Carbon sequestration and the use biomass for energy.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3464 - Sustainable Operations Management (3 credits)
Sustainable business management models of renewable-based materials organizations. Application of strategy deployment tools to sustainable bio business strategies. Analysis of financial statements of bio businesses using ratio analysis. Implementation of models and tools to analyze production systems based on cycle time, throughput, and inventory (factory dynamics). Simulation and optimization of manufacturing systems using probability function models. Statistical quality control charts for discrete and continuous variables.
Prerequisite(s): STAT 2004 or STAT 3615 or STAT 3005 or STAT 3604
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3524 - Manufacture of Sustainable Biomaterials for Structures (3 credits)
Principles of manufacturing sustainable biomaterials into primary and secondary products used in construction of buildings, houses and other structures; product demand and environmental impact; raw material quality and volume estimation; industry standards; manufacturing processes; and quality control methods.
Prerequisite(s): SBIO 2124
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 3554 - Sustainable Biomaterials Enterprises (3 credits)
Processes and techniques in manufacturing sustainable biomaterial-based products. Contemporary manufacturing, industrial engineering, and business practices in enterprises. Problem solving, operations management, and effective leadership in discrete products manufacturing and sustainable biomaterials production practices.
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

SBIO 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 3994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4004 - Senior Seminar in Forest Products Business (2 credits)
Integrated application of principles of management, manufacturing, and marketing as applied to wood-based and related industries. Case analysis, business planning and strategic decision making. Senior standing required.
Prerequisite(s): SBIO 3634
Instructional Contact Hours: (2 Lec, 2 Crd)

SBIO 4024 - Packaging Design for Global Distribution (3 credits)
Understanding, identification, and measurement of hazards in physical distribution including sea, air, and various land transportation, storage methods, and use of sanitation methods. Knowledge, analysis, and selection of sustainable protective packaging materials. Design and analysis of packaging protection against such hazards as shock, vibration compression, and climate. Laboratory testing of shock, vibration and compression, and performance testing of packaging and components. Packaging design in global context.
Prerequisite(s): SBIO 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4054 - Packaging Systems Design Practicum (3 credits)
Integrated application of principles of packaging design and manufacturing. Design briefs, package development process, structural requirements, manufacturing and distribution plans, target markets and positioning. Senior Standing required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4154 - Computer Application Systems in Forest Products (3 credits)
Computer control systems with applications in the forest products industry. Survey of systems for gathering, inputting, conditioning, and managing information. Hardware and software systems for computer control applications. Use of information technologies to integrate control subject to raw material, quality, and market fluctuations. Forest products case studies in data acquisition, data analysis, database management production planning, process control, inventory control, and systems specification. Junior standing is required.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4164 - Sustainability Performance and Assessments (3 credits)
Data analytics, metrics, and tools essential for navigating sustainability standards, current policies, regulations, and reporting requirements, and their applications in sustainable investment. Explore innovations in sustainable investment strategies, emphasizing the integration of sustainability concepts and industrial ecology principles into business frameworks. Case studies approach to illustrate both successful and unsuccessful sustainability strategies across diverse contexts, such as energy sector, manufacturing, among other, providing insights into practical applications and outcomes.
Prerequisite(s): SBIO 2514
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4214 - Food and Health Care Packaging (3 credits)
Designed for both current and advanced food and health care packaging. Covering the types of materials and their properties, fabrication, functions, distribution and packaging life cycle for food and health care packaging systems and design. Reviewing recent trends in food and health care packaging systems; sustainable food packaging, medical device packaging, aseptic packaging, package/product interactions, smart active packaging, handling of packages, and modified atmospheric packaging. Exploration to global food and health care packaging standards and compliance, safety issues, and environmental considerations.
Prerequisite(s): SBIO 3124 and SBIO 3284
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

SBIO 4224 - Industrial Packaging Systems (3 credits)
Principles of pallet design including material selection, pallet repair methods and recycling, properties and selection of pallet fasteners. Principles of industrial packaging systems including handheld containers, bulk bins, drums, pails, bags, intermediate bulk containers, flexible intermediate bulk containers. Principles of unit load design including unit load interactions and application of load stabilizers. Principles of reusable packaging systems, shipping laws and regulations.
Prerequisite(s): SBIO 4024 and SBIO 3224
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4254 - Advanced Manufacturing with Sustainable Biomaterials (3 credits)
Modeling and visualization concepts in computer-aided design (CAD) that facilitate advanced manufacturing technologies. Advanced manufacturing tools such as computer-aided manufacturing (CAM) and computer-aided engineering (CAE) used to study the function, cost, and quality that may result from modeled product concepts. Interactions of model specifications and the materials and manufacturing methods utilized on production results. Data analytics to evaluate tradeoffs in the quality, cost, and sustainability of products utilizing sustainable biomaterials compared to other common materials utilized in manufacturing.
Prerequisite(s): SBIO 2004 and SBIO 3314
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4314 - Design of Wood Structures (3 credits)
Analysis and design of wood structures comprised of solid wood and/or composite wood products. Evaluation of mechanical properties of wood materials. Design of individual tension, compression and bending members, and wood-steel dowel connections. Lateral loading design of diaphragms and shearwalls.
Prerequisite(s): SBIO 3314 or CEE 3404
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEM 4314

SBIO 4384 - Biorefinery Science (3 credits)
Biomass utilization as an industrial resource. Biorefinery processes such as cultivation, harvesting, separation, and biomass processing into industrial products compared to the petroleum refinery. Routes to the production of bioenergy, biochemicals, and biofuels. Resource availability and energy consumption, environmental implications of a biorefinery system, public policy influence on development of biorefineries.
Prerequisite(s): SBIO 3434
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4424 - Polysaccharide Chemistry (3 credits)
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 4424

SBIO 4444 - Plant Polymers & Biocomposites (3 credits)
Evolution of vascular plants and plant polymers in the context of materials science and biocomposites. Anatomical, physical, and mechanical properties of wood, bamboo, and hemp. Polymer science, plant polymer science, surface chemistry, and adhesion science for biocomposites made from wood, bamboo, and hemp. Contemporary adhesives and resins for biocomposites manufacture.
Prerequisite(s): CHEM 2514 or CHEM 2536
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4514 - Wood Products Industry Studies (1 credit)
Field studies of the processing systems and product manufacturing procedures of various wood products industries.
Prerequisite(s): SBIO 3114
Instructional Contact Hours: (3 Lab, 1 Crd)

SBIO 4624 - Wood Industry Production Operations Management (3 credits)
Study of the operation of wood products organizations. Problems facing these organizations and current management practices used to address these problems. Investigation of the design and implementation of wood industry management improvement efforts. How organizations and groups design, implement, and evaluate improvements efforts. The application of techniques to production planning, financial management, inventory management, quality, human resources management, technology, performance measures, and assessment. Includes case studies of wood products manufacturing companies.
Prerequisite(s): SBIO 3544
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

SBIO 4634 - Forest Products Business Management (3 credits)
This course will describe the allocation of resources within a forest products business. Students will determine how to allocate natural, human and financial resources to maximize profitability within the organization. How allocation decisions affect all stakeholders of the organization will be demonstrated and this allocations impact upon strategic planning will be discussed. The course will also show the impact of the external business environment on management decisions.
Prerequisite(s): SBIO 1234 and SBIO 2614 and SBIO 3114
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4714 - Performance of Sustainable Biomaterials in Buildings (3 credits)
The use of manufactured sustainable biomaterials in the construction of buildings; interactions of building code requirements, sustainable biomaterials and bio-composite materials as components within houses; durability, deterioration, controlling moisture infiltration, preservatives and proper selection of materials, historic wood buildings, effectiveness and efficiency of sustainable biomaterial building systems; serviceability issues in buildings with sustainable biomaterials.
Prerequisite(s): SBIO 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

SBIO 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SBIO 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Packaging Systems and Design Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
SBIO 1114	A Sustainable Future through Circular Economy	3
SBIO 2004	Computer-Aided Design in Packaging	3
SBIO 2104	Principles of Packaging	3
SBIO 3124	Paper and Paperboard Packaging	3
SBIO 3224	Packaging Distribution Systems	3
SBIO 3284	Packaging Polymers and Production	3
SBIO 3314	Mechanics of Sustainable Biomaterials and Packaging	4
SBIO 4024	Packaging Design for Global Distribution	3
SBIO 4054	Packaging Systems Design Practicum	3
SBIO 4214	Food and Health Care Packaging	3
SBIO 4224	Industrial Packaging Systems	3
CHEM 2514	Survey of Organic Chemistry	3
Subtotal		37
Business		
Select one of the following:		3
MKTG 3104	Marketing Management	
SBIO 2614	Introduction to Forest Products Marketing	
SBIO 3464	Sustainable Operations Management	
Subtotal		3
Chemical and Physical Sciences		
BIOL 1115	Principles of Biology Laboratory	1
PHYS 2205	General Physics	3
CHEM 1036	General Chemistry	3
Subtotal		7
Restricted Packaging Electives		
Select two of the following:		6
SBIO 2214	Design Fundamentals for Packaging	
SBIO 3104	Packaging Design Applications	
SBIO 3244	Packaging Machinery and Production Systems	
Packaging Experiential Learning		
Select one of the following:		3
SBIO 3005	Sustainable Packaging Design and Innovation	
SBIO 3006	Sustainable Packaging Design and Innovation	
SBIO 3964	Field Study	
SBIO 4994	Undergraduate Research	
or SBIO 3994	Undergraduate Research	
XXXX 3954	Study Abroad	
Free Electives		
Select remaining credit hours to fulfill remaining credits required for graduation.		18
Subtotal		27
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3

STAT 2004	Introductory Statistics (5F)	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) that may be double-counted with another core outcome or major requirement		3
Subtotal		46
Total Credits		**120**

Satisfactory Progress

By the end of the semester in which the student has attempted 60 hours (including transfer, advanced placement, advanced standing, and credit by examination), "satisfactory progress" towards a B.S. degree in the College of Natural Resources and Environment will include the following minimum criteria:

- Having a grade point average of at least 2.0
- Passing at least 24 semester credits that apply towards the Pathways General Education
- Passing the required 1000-level courses in Biology, Chemistry, English, and Math

Graduation Requirements

In-major GPA Computation

Includes all courses designated SBIO. The acceptable minimum is 2.0.

Sequencing

Courses should be taken in a sequence that ensures that any prerequisite or corequisite requirements are met. Free elective courses may also have prerequisite requirements. Students should plan ahead and ensure that they have completed prerequisites or are enrolled in corequisite courses.

Foreign Language Requirement

Two years of one language in high school or complete an 1105-1106 foreign language (e.g. FR, GR, SPAN) grouping or equivalent.

Sustainable Biomaterials Major

Program Curriculum

Minimum credit hours required for graduation is 120.

Code	Title	Credits
Degree Core Requirements		
SBIO 1234	Introduction to Wood, Design and Craftmanship	3
SBIO 2124	Structure and Properties of Sustainable Biomaterials	3
SBIO 3004	Sustainable Nature-Based Enterprises	3
SBIO 3314	Mechanics of Sustainable Biomaterials and Packaging	4
SBIO 3524	Manufacture of Sustainable Biomaterials for Structures	3
STAT 2004	Introductory Statistics	3
Select one of the following:		3
SBIO 1114	A Sustainable Future through Circular Economy	
SBIO 2614	Introduction to Forest Products Marketing	
SBIO 3454	Society, Sustainability Biomaterials and Energy	
SBIO 3464	Sustainable Operations Management	
Select one of the following:		3
SBIO 2994	Undergraduate Research	
SBIO 3445	Entrepreneurial Wood Design and Innovation	
SBIO 3446	Entrepreneurial Wood Design and Innovation	
SBIO 3954	Study Abroad	
SBIO 3964	Field Study	
SBIO 3994	Undergraduate Research	
SBIO 4994	Undergraduate Research	
Subtotal		25
Track Requirements		
Select one of the tracks listed below		49
Subtotal		49
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
or COMM 1015	Communication Skills	
ENGL 1106	First-Year Writing (1F)	3
or COMM 1016	Communication Skills	
Select one course in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology	3
CHEM 1035	General Chemistry	3
CHEM 1045	General Chemistry Laboratory	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
SBIO 2504	Circular Economy Analytics for Sustainable Systems (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		

Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) that may be double-counted with another core outcome or major requirement	3
Subtotal	46
Total Credits	**120**

Track Requirements

Creating Sustainable Society Track

Code	Title	Credits
Requirements		
AAEC 3314	Environmental Law	3
PHYS 2205	General Physics	3
SBIO 3324	Green Building Systems	3
SBIO 3554	Sustainable Biomaterials Enterprises	3
SBIO 4714	Performance of Sustainable Biomaterials in Buildings	3
Select either the following 2 ENGR courses or the following 2 NR courses		6
ENGR 3124	Introduction to Green Engineering	
ENGR 4134	Environmental Life Cycle Assessment	
GEOG/NR 1115	Seeking Sustainability	
GEOG/NR 1116	Seeking Sustainability	
Free Electives		
Select 28 credit hours		28
Total Credits		**49**

Sustainable Biomaterials Business Track

Code	Title	Credits
Requirements		
ACIS 2115	Principles of Accounting	3
PHYS 2205	General Physics	3
MGT 2064	Foundations of Entrepreneurship	3
MGT 3304	Management Theory and Leadership Practice	3
SBIO 2614	Introduction to Forest Products Marketing	3
SBIO 3445 & SBIO 3446	Entrepreneurial Wood Design and Innovation and Entrepreneurial Wood Design and Innovation	6
SBIO 3464	Sustainable Operations Management	3
SBIO 3554	Sustainable Biomaterials Enterprises	3
SBIO 4714	Performance of Sustainable Biomaterials in Buildings	3
Free Electives		
Select 19 credit hours		19
Total Credits		**49**

Sustainable Biomaterials Science Track

Code	Title	Credits
Requirements		
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences	3
CHEM 1036	General Chemistry	3
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CHEM 2535	Organic Chemistry	3
CHEM 2536	Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2546	Organic Chemistry Laboratory	1
CHEM 4615	Physical Chemistry for the Life Sciences	3
PHYS 2205	General Physics	3
PHYS 2206	General Physics	3
SBIO 3434	Chemistry and Conversion of Sustainable Biomaterials	3
SBIO 4444	Plant Polymers & Biocomposites	3
SBIO 3444 or SBIO 4424	Sustainable Biomaterials and Bioenergy Polysaccharide Chemistry	3
Free Electives		
Select 13 credit hours		13
Total Credits		**49**

Sustainable Residential Structures Track

Code	Title	Credits
Requirements		
CHEM 1036	General Chemistry	3
PHYS 2205	General Physics	3
RED 1604	Introduction to Residential Design	3
SBIO 2314	Building Information Modeling for Wood-Based Construction	3
SBIO 3324	Green Building Systems	3
SBIO/CEM 4314	Design of Wood Structures	3
SBIO 4714	Performance of Sustainable Biomaterials in Buildings	3
Free Electives		
Select 28 credit hours		28
Total Credits		**49**

College of Science

Our Website (http://www.science.vt.edu)

Overview

The College of Science at Virginia Tech provides students with interdisciplinary training in analytical skills, a comprehensive foundation in the tools of science and the scientific method, and rigorous education in any of a wide variety of scientific fields. Outstanding faculty members conduct research and teach courses in fourteen disciplines leading to baccalaureate and advanced degrees. Coursework from the College of Science further provides a foundation of knowledge in a number of fundamental and advanced subjects for students in all Colleges across the campus. The College of Science also offers academic advising and appropriate preparatory coursework for students interested in pre-medicine, pre-dentistry, pre-veterinary medicine, and patent or intellectual property law.

The college supports research centers in areas such as biomedical and public health sciences, applied mathematics, macromolecular science, and many other critical technologies and applied sciences that interface with other Colleges at the University. Allied disciplines emphasize the study of behavioral science as well as economic and strategic decision

making. The College is committed to providing research opportunities for interested students at all levels.

General Requirements for Graduation

A student in the College of Science must complete at least 120 hours for an undergraduate degree as well as satisfying the following requirements:

- achieve a minimum overall Grade Point Average (GPA) established for their degree by the major department for all hours attempted
- achieve a minimum in-major GPA established for their major by the department for all hours attempted in all work applied to the major
- complete all other requirements established for their degree by the major department
- complete all college and General Education (Pathways General Education) requirements

No course required for the major/minor may be elected to be taken on a pass/fail (P/F) basis (i.e., pass/fail may be used for free electives only). This excludes courses that are offered P/F only.

College Core Curriculum

A description of the General Education Requirements (Pathways General Education) may be found in the Academics chapter of this catalog or on the Pathways General Education website (www.pathways.prov.vt.edu (http://www.pathways.prov.vt.edu)).

Foreign Language

Students must complete the second year (level II) of a single foreign language [including Sign Language (ESL)] in a secondary school. This requirement may also be fulfilled by successful completion of one of the following:

- Satisfactorily complete 1106 for any foreign language offered including any prerequisites
- Satisfactorily complete an accelerated course which combines 1105 and 1106 of a foreign language
- Students who have not completed two (2) units of a single foreign language in high school must satisfactorily complete 1106 or an accelerated course which combines 1105 and 1106 of a foreign language. These hours are in addition to the 120 hours required for graduation, so these hours will not count towards graduation.
- Credit by examination for a foreign or classical language. The credit by examination option is available only to students who have gained knowledge of a foreign language without the benefit of formal training. This option is intended to recognize informal, non-academic learning experience. This option is restricted and does not carry credit towards graduation. Requests must be made through the Foreign Language office. See https://clep.collegeboard.org for available tests and procedures.
- Students whose native language is not English may be exempted from the foreign language requirement.

Honors College

The Honors College welcomes highly motivated College of Science students. The mission of the Honors College is to inspire and facilitate an extraordinary education for students of exceptional ability who seek to be active learners and who will apply their knowledge and skills to critical real-world problems.

Currently enrolled Virginia Tech students will receive an invitation to apply to the Honors College at the end of each fall or spring semester, provided they have achieved a 3.40 or better cumulative GPA and have at least four (4) semesters remaining at Virginia Tech before they graduate. More information about honors academic requirements and how to earn an honors diploma is available on the Honors College website: https://www.honorscollege.vt.edu.

Integrated Science Curriculum

Designed for students seeking an in-depth understanding of 21st century science, the Integrated Science Curriculum (ISC) provides a novel, integrated scientific foundation for any degree program in the College of Science. It employs a collaborative, active-learning environment emphasizing teamwork, skill acquisition, independent thought, and creativity. Structurally, ISC is a 30-credit two-year course sequence that covers the fundamentals of college-level chemistry, physics, and biology integrated with each other and with calculus and linear algebra. Teamwork, written and oral presentation, and problem-solving are central components throughout the curriculum. See a full description of the ISC at https://www.ais.science.vt.edu/academics/isc.html.

Dean's List

An undergraduate student who attempts at least 12 credit hours graded on the A-F option and who earns a 3.4 GPA for either spring or fall semester will be included on the online Dean's List for that term. Please note: Students will not appear on the online Dean's List if they are listed in the system as confidential or if they do not have an active permanent address. Questions about omissions from the online list should be directed to the Office of the University Registrar.

Pre-Professional Advising in the College of Science

Career and Professional Development offers advising to all students who are considering graduate or professional school as part of their career planning process. Students are welcome to seek advising for decision-making on whether graduate school is the path to their career goal, how to research school and programs, and reviews resumes and personal statements. Students interested in any health profession requiring graduate or professional school are encouraged to participate in health professions advising https://career.vt.edu/advising/hpa.html. Health professions advising is particularly helpful in advising students interested in nursing, dentistry, optometry, veterinary medicine, allopathic medicine (MD), osteopathic medicine (OD), physical therapy, becoming a physician's assistant/nurse practitioner, etc. Advising for students interested in patent or intellectual property law careers is available in the college advising center.

Phi Beta Kappa

Phi Beta Kappa is the oldest and most prestigious honor society dedicated to recognizing excellence in the liberal arts and sciences. Students in the College of Science who have exhibited outstanding academic ability in eligible coursework may be eligible for selection to Phi Beta Kappa.

Scholarships

A number of scholarships are available for outstanding students enrolled in the College of Science. Descriptions and deadlines are available on the Scholarships and Financial Aid website.

Undergraduate Research

Research opportunities and experiencing the excitement of discovery can play an important part in undergraduate training in science. College of Science departments offer diverse research opportunities in which students may choose to participate. Individuals interested in undergraduate research should contact a faculty member in the department where they wish to conduct research.

Internships, Co-op Opportunities, and Enrichment Programs

Students are encouraged to participate in internship and co-op opportunities to gain relevant work experience prior to graduation. Career advisors in the college advising center as well as departmental career advisors can help students identify opportunities. In some cases, students can receive credit for qualifying work experience. Enrichment studies include field station opportunities, study abroad and summer laboratory experiences outside of the university.

Career Advising

Career advising is available from a number of sources. The centralized Career and Professional Development, located at the Smith Career Center, offers many services to aid with your career journey. Beginning with career and major exploration early in your time on campus, through the process of assisting you in the job search or graduate and professional school application, Career and Professional Development advisors can be a resource for you along the way. Career advisors have resources to guide your every step in the career journey, as well as assisting in gaining valuable experience through internships and other opportunities in your career field(s) of interest. Specialized Health Professions Advisors are also available for those that are choosing to pursue post-graduate education in a Health Profession. For more information, visit www.career.vt.edu (http://www.career.vt.edu). The departments within the College of Science also host panels and information sessions with employers interested in hiring students with degrees from the college. Every major has departmental advisors who specialize in guiding students from their field towards career success.

As part of a service to you, Career and Professional Development offers each student a **free** Handshake account. Students who are seeking any type of career-related experience or employment, including internships, co-ops, career-related summer employment, and permanent positions are eligible to use Handshake. You may upload your resume, search for companies interested in Virginia Tech students, apply for positions, review job fairs, and sign up for on-campus interviews listed in Handshake. Additional information about this resource can be found at https://career.vt.edu/job-search/Handshake.html.

Graduate Programs in Science

College of Science departments offer graduate degrees at both the Master's and Ph.D. levels. Complete information on these programs including descriptions of graduate courses can be found in the Graduate Catalog (https://secure.graduateschool.vt.edu/graduate_catalog/).

Degree Programs

- Biological Sciences Major (p. 1229)
- Biological Sciences Major with Biology Education Option (p. 1232)
- Biological Sciences Major with Biomedical Option (p. 1234)
- Biological Sciences Major with Ecology, Evolution, and Behavior Option (p. 1236)
- Chemistry Major (B.A.) (p. 1249)
- Chemistry Major (B.S.) (p. 1250)
- Clinical Neuroscience Major (p. 1319)
- Cognitive and Behavioral Neuroscience Major (p. 1321)
- Computational and Systems Neuroscience Major (p. 1324)
- Computational Modeling and Data Analytics Major (p. 1258)
- Computational Modeling and Data Analytics Major with Biological Sciences Option (p. 1259)
- Computational Modeling and Data Analytics Major with Cryptography and Cybersecurity Option (p. 1261)
- Computational Modeling and Data Analytics Major with Economics Option (p. 1262)
- Computational Modeling and Data Analytics Major with Geosciences Option (p. 1263)
- Computational Modeling and Data Analytics Major with Physics Option (p. 1265)
- Economics Major (p. 1271)
- Economics Major with Business Option (p. 1272)
- Economics Major with Managerial Economics and Data Science Option (p. 1274)
- Economics Major with Policy and Regulation Option (p. 1276)
- Experimental Neuroscience Major (p. 1326)
- Geosciences Major with Earth Science Education Option (p. 1284)
- Geosciences Major with Environmental and Engineering Geoscience Option (p. 1285)
- Geosciences Major with Geobiology & Paleobiology Option (p. 1287)
- Geosciences Major with Geochemistry Option (p. 1288)
- Geosciences Major with Geology Option (p. 1291)
- Geosciences Major with Geophysics Option (p. 1292)
- Mathematics Major (p. 1301)
- Mathematics Major with Applied and Discrete Mathematics Option (p. 1303)
- Mathematics Major with Applied Computational Mathematics Option (p. 1305)
- Mathematics Major with Mathematics Education (Master's Track) Option (p. 1307)
- Medicinal Chemistry Major (p. 1252)
- Microbiology Major (p. 1239)
- Microbiology Major with Biomedical Option (p. 1241)
- Nanomedicine Major (p. 1311)
- Nanoscience Major (p. 1313)
- Physics Major (p. 1335)
- Physics Major (p. 1337)
- Physics Major with Physics Education Option (p. 1338)
- Physics Major with Pre-Health Option (p. 1340)
- Physics Major with Pre-Law Option (p. 1342)
- Polymer Chemistry Major (p. 1254)
- Psychology Major (p. 1347)
- Statistics Majors with Statistical Data Science Option (p. 1354)

- Statistics Majors with Statistical Methods and Theory Option (p. 1356)
- Systems Biology Major (p. 1360)

Dean: Kevin Pitts
Associate Dean for Research: John Morris
Associate Dean for Faculty Affairs and Graduate Studies: Patricia Hammer
Associate Dean for Undergraduate Programs: Michel Pleimling
Assistant Dean for Outreach and Student Engagement: Victoria Corbin
Assistant Dean for Research in the National Capital Region: Laura Freeman
Assistant Dean for Inclusion and Diversity: Estrella Johnson
Assistant Dean for Finance: Will Walton
Assistant Dean for Advancement: Michael Walsh

COS 1004 - Explore Science Seminar (2 credits)
Overview of the college and its degrees as well as the various career opportunities available to College of Science graduates. Introduction to University resources that aid in strategic academic and career planning. Intended for first-year Explore Science majors in the College of Science.
Instructional Contact Hours: (2 Lec, 2 Crd)

COS 1015 - Successful Starts in Science: Curie and Da Vinci Living Learning Communities (1 credit)
First year experience course for students living in the Curie or Da Vinci Living Learning Communities at Virginia Tech. Provides resources and fundamental skills to enhance learning experiences and support academic success in the sciences. Engages students with professional and academic development activities both in the classroom and within a science-themed residence hall. Uses a learn by doing approach to blending technical know-how with leadership, ethical, interpersonal and professional skills fundamental to the practice of science. Requires teamwork to envision, design, and implement research projects while using innovative discipline-specific technology. Provides first-year students with support through a weekly peer mentoring program. 1015: Emphasis on scientific inquiry, curriculum planning, career planning in the sciences, skills to promote academic success, awareness of academic and career resources and opportunities. 1016: Emphasis on collaborative problem-solving skills using innovative discipline-specific technology, critical thinking; Integration of ideas and experiences to encourage life-long learning through service work related to their academic/ career interests.
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 1016 - Successful Starts in Science: Curie and Da Vinci Living Learning Communities (1 credit)
First year experience course for students living in the Curie or Da Vinci Living Learning Communities at Virginia Tech. Provides resources and fundamental skills to enhance learning experiences adn support academic success in the sciences. Engages students with professional and academic development activities both in the classroom and within a science-themed residence hall. Uses a learn by doing approach to blending technical know-how with leadership, ethical, interpersonal and professional skills fundamental to the practice of science. Requires teamwork to envision, design, and implement research projects while using innovative discipline-specific technology. Provides first-year students with support through a weekly peer mentoring program. 1015: Emphasis on scientific inquiry, curriculum planning, career planning in the sciences, skills to promote academic success, awarenenss of academic and career resources and opportunities. 1016: Emphasis on collaborative problem- solving skills using innovative discipline-specific technology, critical thinking; Integration of ideas and experiences to encourage life-long learning through service work related to their academic/career interests.
Prerequisite(s): COS 1015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2015 - Professional Leadership in Science: Curie and Da Vinci LLC Leadership Course (1 credit)
Leadership and professional development course for sophomore science majors in the Curie and Da Vinci Living Learning Communities (LLCs). Applied experience in fundamental leadership and project management skills associated with practice of science, gained through service learning within the LLC. 2015: Academic peer mentoring, application and development of leadership and communication skills; application and development of project planning, organizational and collaboration skills; emphasis on written communication skills. 2016: Application of team mentoring and project management skills, including project planning and coordination, leadership strategies, collaboration, communication, conflict resolution, understanding group dynamics and the importance of diversity, and facilitating group discussion on scientific problem solving; emphasis on verbal communication skills.
Prerequisite(s): COS 1016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 2016 - Professional Leadership in Science: Curie and Da Vinci LLC Leadership Course (1 credit)
Prerequisite(s): COS 2015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 2164 - Introduction to Scieneering (1 credit)
Seminar-based course providing a survey of current interdisciplinary science and engineering research problems; introduction to interdisciplinary thinking and communication; issues related to interdisciplinary research teams.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: ENGR 2164

COS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 3015 - Applications of Leadership in the Orion Science Living Learning Community (1 credit)
Applications of science leadership for sophomore through senior students in the Orion Science Living Learning Community (LLC). Students learn leadership skills while mentoring and designing activities to help younger students develop skills needed to succeed in college and future science careers. 3015: Recognize the needs of first- and second-year college students: help students find their own solutions; cooperatively plan and run activities that help first- and second-year college students develop professional skills and meet learning objectives; practice communication and motivation skills; model professional and ethical conduct; assess self as a learner and a leader. 3016: Coach teams and manage projects: help first- and second-year college students to apply their existing knowledge to a new project; identify problem-solving strategies and propose solutions; facilitate teamwork; communicate scientific information to the public in writing and orally; articulate the relationship between service to others and effective leadership.
Prerequisite(s): COS 1016 or COS 2016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 3016 - Applications of Leadership in the Orion Science Living Learning Community (1 credit)
Applications of science leadership for sophomore through senior students in the Orion Science Living Learning Community (LLC). Students learn leadership skills while mentoring and designing activities to help younger students develop skills needed to succeed in college and future science careers. 3015: Recognize the needs of first- and second-year college students: help students find their own solutions; cooperatively plan and run activities that help first- and second-year college students develop professional skills and meet learning objectives; practice communication and motivation skills; model professional and ethical conduct; assess self as a learner and a leader. 3016: Coach teams and manage projects: help first- and second-year college students to apply their existing knowledge to a new project; identify problem-solving strategies and propose solutions; facilitate teamwork; communicate scientific information to the public in writing and orally; articulate the relationship between service to others and effective leadership.
Prerequisite(s): COS 3015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4015 - Supervision in Science: Orion Living Learning Community (1 credit)
Supervision in Science is a course for junior through senior students in the Orion Living Learning Community (LLC). Students learn more advanced management and supervisory skills while working closely with Orion LLC faculty and staff to build on previously learned mentorship, leadership, and lesson/event planning skills to help younger students develop skills needed for success in college and future science careers. 4015: Recognize the needs and manage activities of first, second, and third year college students: assess self as a peer supervisor; develop an individual development plan (IDP) for peer supervisors with Orion LLC Directors; model professional and ethical conduct; effectively and positively motivate teams of first, second, and third year students to meet learning objectives and develop professional skills; help first, second, and third year college students effectively and professionally communicate needs. 4016: Apply supervisory skills to managing and coaching student teams toward completion of program activities and projects: reassess and revise individual development plan (IDP) for peer supervisory role with Orion LLC Directors; help second and third year college students effectively motivate and guide first year students toward the completion of a group research project; help younger students communicate scientific information to the public orally and in writing; facilitate conflict resolution; promote professional and timely communication for second and third year college students; articulate the role of supervision as an aspiring science professional.
Prerequisite(s): COS 3016
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4016 - Supervision in Science: Orion Living Learning Community (1 credit)
Supervision in Science is a course for junior through senior students in the Orion Living Learning Community (LLC). Students learn more advanced management and supervisory skills while working closely with Orion LLC faculty and staff to build on previously learned mentorship, leadership, and lesson/event planning skills to help younger students develop skills needed for success in college and future science careers. 4015: Recognize the needs and manage activities of first, second, and third year college students: assess self as a peer supervisor; develop an individual development plan (IDP) for peer supervisors with Orion LLC Directors; model professional and ethical conduct; effectively and positively motivate teams of first, second, and third year students to meet learning objectives and develop professional skills; help first, second, and third year college students effectively and professionally communicate needs. 4016: Apply supervisory skills to managing and coaching student teams toward completion of program activities and projects: reassess and revise individual development plan (IDP) for peer supervisory role with Orion LLC Directors; help second and third year college students effectively motivate and guide first year students toward the completion of a group research project; help younger students communicate scientific information to the public orally and in writing; facilitate conflict resolution; promote professional and timely communication for second and third year college students; articulate the role of supervision as an aspiring science professional.
Prerequisite(s): COS 4015
Instructional Contact Hours: (1 Lec, 1 Crd)

COS 4064 - Scieneering Capstone (3 credits)
A capstone experience centered around an open-ended, faculty-advised senior project involving the design of a process, material, or technique for solving an interdisciplinary problem. Pre: Enrollment in Interdisciplinary Engineering and Science Minor.
Prerequisite(s): ENGR 2464 or BIOL 2124
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGR 4064

COS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 5974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

COS 5984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Biological Sciences

Our Website (http://www.biol.vt.edu)

Overview

The Department of Biological Sciences offers two B.S. degree paths: the B.S. in Biological Sciences and the B.S. in Microbiology.

The B.S. in Biological Sciences program provides majors with a broad education in the study of life. This curriculum exposes students to the fundamentals of the discipline: genetics, cell and molecular biology, evolutionary biology, and ecology. In addition, Biological Sciences majors may take advantage of elective courses on topics such as macromolecular structure, pathogenic bacteriology, cancer biology, infectious disease ecology, human genetics, and global change ecology. Students may choose to complete an option in one of the following three areas: Biomedical; Ecology, Evolution, and Behavior (EEB); or Biology Education.

The B.S. in Microbiology program provides majors with a more focused education in the biology and roles of microscopic life forms present in our environments. The laboratory-intensive curriculum provides knowledge in the genetics and physiology common to all microbes and allows students to explore specific interests with a broad range of advanced electives such as pathogenic bacteriology, immunology, environmental microbiology, food microbiology, virology, microbial forensics, and bioinformatics.

Modern biology increasingly relies on knowledge, skills, and perspectives associated with other scientific fields, particularly chemistry, mathematics, physics and statistics. Success in biological sciences-associated careers requires students to master the fundamentals of these cognate fields and to be able to apply these skill sets.

As a scientific discipline, biology is more than simple knowledge about living organisms. By integrating education and research, our majors are training to be leaders in their field who practice innovative and interdisciplinary approaches in biological research. By participating in undergraduate research during the academic year, our students are discovering through hands-on experience what it means to Invent the Future. Our majors are strongly encouraged to explore internships and research opportunities on campus and elsewhere during the summer.

The majority of our graduates continue on to advanced studies in the health professions or in various branches of the biological sciences. Graduates pursue professional degrees in medicine, dentistry, veterinary medicine, pharmacy, and nursing, or M.S. or Ph.D. degrees in ecology, environmental biology, microbiology, botany, zoology, cell biology, molecular biology, and biomedical sciences. Students interested in entering the workforce are provided the core background for opportunities in biotechnology, food science, bioinformatics, bio-business, and health-related industries.

Preparation for Advanced Study

Graduate Study

Students who satisfactorily complete the undergraduate curriculum in biological sciences or microbiology may pursue advanced studies leading to the M.S. or Ph.D. in various branches of the biological sciences. Those interested in teaching science are prepared to pursue the M.A.Ed.

Preparation for Medicine

The training afforded by the first three years (approximately 96 hours) meets the pre-medical training requirements of medical colleges that accept students with only three years of undergraduate work. It is strongly recommended, however, that all students complete a B.S. before entering medical school.

Preparation for Dentistry

Dental colleges require a minimum of three years of college training for admission, but it is generally advisable for students to complete the B.S. before entering dental school.

Preparation for Allied Health Professions

Schools of Allied Health Professions, such as nursing, pharmacy, medical technology, physical therapy, etc., require two or more years of college work for admission. Specific requirements are available from Career and Professional Development or the Biological Sciences Department.

Preparation for Veterinary Medicine

Veterinary schools require a minimum of three years of college training for admission. Few students who meet only the minimum entrance requirements are accepted by veterinary schools.

Minor Requirements

The requirements to earn a minor in Biology can be found on its checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Biological Sciences Major (p. 1229)
- Biological Sciences Major with Biology Education Option (p. 1232)
- Biological Sciences Major with Biomedical Option (p. 1234)
- Biological Sciences Major with Ecology, Evolution, and Behavior Option (p. 1236)
- Microbiology Major (p. 1239)
- Microbiology Major with Biomedical Option (p. 1241)

Head: Robert S. Cohen
Harold H. Bailey Endowed Chair: J. R. Walters[6]

Professors: J. Barrett, L. K. Belden, C. Carey, D. Cimini, C. Finkielstein, M. J. Friedlander, D. Hawley[3,7], A. LaMantia, I. Lazar, L. Li[6], S. B. Melville, I. T. Moore[3], D. L. Popham, B. Scharf, J. Sible[7,10], A. M. Stevens[3,7], D. Tholl, Q. Thomas, B. S. J. Winkel[10], and Z. Yang
Associate Professors: F. Aylward, B. Brown, D. Capelluto, J. Chen, V. Corbin, S. Hauf, E. R. Hotchkiss, S. Kojima, K. Langwig, J. W. McGlothlin, M. C. Mims, F. Schubot, K. Sewall, J. Smyth, J. C. Uyeda, R. A. Walker[3,7], and S. R. Whitehead
Assistant Professors: J. Allen, D. Cortes Estrada, J. Draghi, V. Gómez-Bahamón, A. D. Gray, J. Hoyt, B. Hsu, A. Igwe, S. R. Johnstone, H. Lam, R. Márquez, J. Moss, J. Pfleger, A. Suvorov, and J. Vargas-Muniz
Assistant Professor of Practice: J. G. Tokuhisa
Senior Instructors: J. Evans[1], E. P. Hogan, M. V. Lipscomb[3], M. S. Rosenzweig[3,4], and R. W. Seyler
Advanced Instructors: M. M. Emori[4], S. M. Voshell, J. I. Watkinson, and B. D. Wills
Instructor: K. A. Bretz
Curator of the Massey Herbarium: J. S. Metzgar

Footnotes:

1 Award for Excellence in Undergraduate Advising
2 Academy of Teaching Excellence inductee
3 Wine Award recipient
4 Sporn Award recipient
5 Alumni Award for Extension Excellence
6 Alumni Award for Research Excellence
7 Alumni Award for Teaching Excellence
8 Academy of Faculty Service
9 Commonwealth of Virginia Outstanding Faculty Award
10 Diggs Teaching Scholar Awards

Undergraduate Course Descriptions (BIOL)

BIOL 1004 - Biology Orientation Seminar (1 credit)
An introduction to academic and career planning for majors in Biology and students who may be considering Biology as a major.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1014 - Introduction to Biology (3 credits)
Introductory biology for non-life science majors. Topics covered include the hierarchy of living systems, cell structure, physiology, and reproduction, Mendelian genetics, molecular genetics, evolution, microbial diversity, plant anatomy and physiology, animal anatomy and physiology, and ecological systems. Ethical aspects of current research in these areas. Partially duplicates 1005, 1006, 1105, 1106.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1024 - Cancer: Causes, Treatments, Costs (3 credits)
Introduction to risk factors and biological mechanisms associated with cancer. Current approaches to cancer prevention, diagnosis, and treatment. Personal, socioeconomic, and global aspects of cancer.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1034 - Biology of Sex (3 credits)
Sexual reproduction in living organisms from a scientific perspective including morphology, physiology, behavior, development and evolution. Biological basis and ethical considerations of human societal issues including contraception, homosexuality, and gender/sex.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1054 - Human Biology: Concepts and Current Issues (3 credits)
Survey of human biology, including physiology, genetics, evolution, and ecology. Focus on homeostasis, including factors and choices that disrupt homeostasis and health. Examination of technological advances and ethical issues associated with the biology of humans. Personal and societal choices that impact human ecology.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1064 - Plants and Civilization (3 credits)
Survey of basic plant biology. Critical roles of plants as food, drugs, textiles, other products. Examination of the global, historical, and cultural links between plants and humans. Discussion of current topics, including biotechnology, global change, biodiversity loss, nutrition and drug addiction.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1074 - How Animals Think (3 credits)
Overview of scientific research on animal cognition and behavior from perspectives in biology, psychology, and neuroscience. Study and application of scientific approaches to the study of animal cognition and behavior in the context of personal, political, and societal decision making. Considers the influence of animal cognition and animal ethics on decisions about human-animal interactions at a personal and societal scale ranging from decisions about food supply to conservation. Provides the framework to evaluate animal personality, emotion, consciousness, and rights. Addresses how cultural, social and political views influence scientific research on animal cognition. Consideration of bidirectional effects of human-animal interactions on One Health and animal welfare.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1105 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014)
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1106 - Principles of Biology (3 credits)
Introduction to the science of biology. 1105: living systems; biological molecules; cell structure, function, and reproduction; cellular energetics and metabolism; expression and inheritance of genetic information; evolution; ethical implications of research and discovery in these areas. 1106: animal and plant anatomy and physiology, ecology, and animal behavior; ethical implications of research and discovery in these areas. (1105 duplicates 1005, 1014; 1106 duplicates 1006, 1014. Credit for 1014 will be disallowed if 1105 or 1106 are taken after earning credit for 1014).
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 1115 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences. (Duplicates 1015 1016, 1125, 1126).
Corequisite(s): BIOL 1105
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1116 - Principles of Biology Laboratory (1 credit)
Emphasizes biological principles through investigative exercises and collaborative learning. 1115: cell chemistry, physiology and reproduction and genetics; 1116: plant and animal form and function, and ecology. Primarily for students majoring in the life sciences.
Corequisite(s): BIOL 1106
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 1135 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1136 - Phage Hunters (2 credits)
Isolation, identification, and characterization of bacteriophages from environmental sources. 1135: Bacteriophage DNA purification, genomic analysis, imaging, and sequencing. 1136: Bioinformatic characterization and annotation of sequenced bacteriophage genomes, comparative genomic analysis, submission of bacteriophage sequence data to public databases.
Prerequisite(s): BIOL 1135
Instructional Contact Hours: (6 Lab, 2 Crd)

BIOL 1214 - Careers in Medicine (1 credit)
For students considering a career in health care. Investigation of various health care professions, including requirements for additional education and the professional and personal expectations characteristic of these professions. Introduction to biomedical ethics and health policy. Options for financing professional school. How to become a competitive applicant.
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2004 - Genetics (3 credits)
Mendelian transmission, chromosome behavior and organization, gene and chromosome mutation, genetic properties of nucleic acids, gene expression and development, DNA technology.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or CHEM 1016 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2124 - Cell and Molecular Biology for Engineers (2 credits)
Composition, structure and function of cells; fundamentals of gene expressions, cell physiology, cellular movement and reproduction; stem cells and tissue formation; synthetic biology and applied cell and molecular biology. Not for Biological Sciences majors.
Prerequisite(s): ENGR 2164 or COS 2164
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 2134 - Cell Function and Differentiation (3 credits)
Fundamental mechanisms essential for cell function. Methods used to study cells. Cellular structure and physiology, energy production, cell survival and reproduction. Cell interactions and communication, stem cells, cell differentiation, tissue formation.
Prerequisite(s): BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2304 - Plant Biology (3 credits)
Introductory botany. Form, growth, function, reproduction, and ecological adaptations of major groups of plants.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HORT 2304

BIOL 2404 - Biotechnology in A Global Society (3 credits)
Introduction to the world-wide impact of biotechnology and molecular biology, including applications to plants, animals, and microorganisms. Explores basic concepts of genetic engineering, scientific and ethical issues, and public concerns related to biotechnology. Topics include: environmental release of genetically engineering organisms, bioremediation, safety of genetically engineered food products, transgenic plants and animals, gene therapy, and genetic screening.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H) and CHEM 1015 and CHEM 1016
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 2404

BIOL 2504 - General Zoology (3 credits)
Morphology, features, adaptations, and ecology of major animal groups, emphasizing major patterns of evolutionary change.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2604 - General Microbiology (3 credits)
Microbial structure, function, metabolism, genetics and ecology. The role of microorganisms in host/parasite relationships will be emphasized.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2614 - General Microbiology Laboratory (1-2 credits)
Introduction to microbiological techniques and procedures. Aseptic technique and safe handling. Culture, characterization, and identification of microorganisms.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106 and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 2105)
Corequisite(s): BIOL 2604
Instructional Contact Hours: (2-4 Lab, 1-2 Crd)

BIOL 2704 - Evolutionary Biology (3 credits)
Evolutionary mechanisms, systematic principles, and theories of the origin and evolution of life.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2804 - Ecology (3 credits)
Fundamental interaction of organisms with the biotic and abiotic components of ecosystems. Topics will include: physical environment and organismic interactions, concepts of population ecology and community ecology, ecosystems interactions, and environmental problems.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2984D - Special Study (1-19 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: Variable credit course

BIOL 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 3014 - Insect Biology (2 credits)
Insect biology provides an introduction to the science of entomology. The course covers the diversity of insects, their biology and behavior, the importance of insects and insect control programs in agriculture, and the effects that insects have had on human history and culture. Laboratory (3024) is optional.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: ENT 3014

BIOL 3024 - Insect Biology Laboratory (2 credits)
Taxonomy and ecology of insects commonly encountered. Identification of all orders and many common families. Ecological attributes of each taxon, including food, habitat, life cycle, and behavior. An insect collection is required.
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 and BIOL 1106) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3014
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: ENT 3024

BIOL 3104 - Cell and Molecular Biology Laboratory (1 credit)
Introduction to methods used to study prokaryotic and eukaryotic cells. Recombinant DNA, protein expression and purification, the polymerase chain reaction, bioinformatics, and microscopy.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 3134 - Human Genetics (3 credits)
Principles of genetic analysis in humans with emphasis on genetic diseases of humans; methods of karyotyping human chromosomes; methods of pedigree and genetic analysis of humans; principles, techniques, and analysis of twin studies in humans; techniques used to identify and characterize normal and abnormal chromosomes; principles and methods of DNA fingerprint analysis of humans.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3204 - Plant Taxonomy (3 credits)
Systematic survey of vascular plants, emphasizing identification, terminology, classification, evolutionary relationships.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3254 - Medical and Veterinary Entomology (3 credits)
An introduction to the roles of insects and other arthropods in the direct causation of disease in humans and animals, and as vectors in the transmission of disease organisms. The epidemiology and replication cycles of vector-borne pathogens with major medical and veterinary importance will be examined. Information will be provided on the biology and behavior of disease vectors and external parasites, and on the annoying and venomous pests of humans and animals. Mechanisms of control will be discussed
Prerequisite(s): (BIOL 1005 and BIOL 1006) or (BIOL 1105 or (BIOL 1205H and BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENT 3254

BIOL 3264 - Medical and Veterinary Entomology Laboratory (1 credit)
Taxonomy and anatomy of insects and arthropods of medical and veterinary importance. Examination of feeding behavior and ecology. Emphasis on the mechanism of injury or pathogen transmission by each group.
Prerequisite(s): (BIOL 1105 and BIOL 1106) or (BIOL 1005 and BIOL 1006) or (BIOL 1205H and BIOL 1206H)
Corequisite(s): BIOL 3254
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: ENT 3264

BIOL 3404 - Introductory Animal Physiology (3 credits)
A comparative systems level approach to the physiology of animals, emphasizing vertebrates: metabolic, temperature, osmotic, and ionic regulation; function of respiratory, circulatory, digestive, muscle, nervous, and locomotory systems; endocrine regulation and biological rhythms. Must have prerequisites or instructors permission.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3454 - Introductory Parasitology (4 credits)
Ecology, taxonomy, morphology, life cycles, pathogenesis, and host-parasite relationships of parasitic eukaryotes.
Prerequisite(s): (BIOL 1105 or ISC 2105) and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 3514 - Introduction to Histology (3 credits)
Overview of tissue structure and function in the human body; microscopic examination of tissue sections; organization of tissues in different organ systems; histopathology of tissues and organs.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 3604 - Food Microbiology (4 credits)
Role of microorganisms in foodborne illness, food quality, spoilage, and preservation. Control of microorganisms in foods. Methods to enumerate, identify, and characterize microorganisms in foods.
Prerequisite(s): BIOL 2604 and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: FST 3604

BIOL 3764 - Careers in Microbiology (3 credits)
Contemporary research topics in microbiology, methods of research data analysis, the research publication process, research presentation and interview skills, career paths for microbiology graduates, preparation for graduate school, preparation for entry into the job market.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3774 - Molecular Biology (3 credits)
Advanced study of the molecular biology of prokaryotic and eukaryotic cells, including mechanisms of gene expression and regulation, relative merits of experimental model systems, and practical applications in agriculture and medicine.
Prerequisite(s): BIOL 2134 or ALS 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 3804 - Principles of Biology Teaching Assistant (2 credits)
For undergraduate teaching assistants (UTAs) facilitating BIOL 1105 or 1106 class sections that utilize active-learning pedagogies and require facilitation of in-class learning activities. Content and practice of teaching strategies and professionalism in the classroom. Supervision by departmental faculty or staff. Selection by Principles of Biology instructional team. May be repeated four times with different content for a maximum of eight credits. Junior Standing, overall minimum GPA of 3.0.
Prerequisite(s): BIOL 1105 and BIOL 1106
Instructional Contact Hours: (6 Lab, 2 Crd)
Repeatability: up to 8 credit hours

BIOL 3814 - Careers In Biological Sciences (1 credit)
Exploration of career opportunities in the biological sciences, including employment and further education. Professional development activities, including resumes, career fairs, networking, preparation for interviews, ethics, and assessment and comparison of job offers. Does not count for Biological Sciences or Microbiology elective credit. Pre: junior standing
Instructional Contact Hours: (1 Lec, 1 Crd)

BIOL 3954 - Study Abroad (1-6 credits)
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)

BIOL 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4004 - Freshwater Ecology (4 credits)
Interactions of physical, chemical, and biological properties of freshwater ecosystems.
Prerequisite(s): BIOL 2804 or BIOL 2804H
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4014 - Environmental Toxicology (2 credits)
Discussion of ecotoxicological and philosophical issues in the development of standards for control of toxic chemicals in freshwater, including site-specific examples, application of current control methods, recovery of damaged ecosystems, and government regulations.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (2 Lec, 2 Crd)

BIOL 4104 - Developmental Biology (3 credits)
Morphological, physiological, and molecular events in embryological and developmental systems, including regulation at the level of transcription, translation, and enzyme or hormone activation.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4114 - Global Change Ecology (3 credits)
Effects of human alteration of climate, landscapes and biogeochemical cycling on ecological structure and functioning at the global scale. Influence of global changes on ecosystem processes and biodiversity with paleo- and contemporary examples. Current and future potential feedbacks between biological systems and the global environment.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4134 - Evolutionary Genetics (3 credits)
Genetic variation, Hardy-Weinberg equilibrium, agents of change in gene frequencies, molecular evolution, mechanisms of speciation. Comparison of theoretical models with natural and laboratory populations.
Prerequisite(s): BIOL 2004 and (BIOL 2704 or BIOL 2704H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4164 - Environmental Microbiology (3 credits)
Ecology, physiology, and diversity of soil and aquatic microorganisms; incorporates the significance of these topics within the context of environmental applications such as bioremediation, wastewater treatment, control of plant- pathogens in agriculture, and pollution abatement in natural systems. The laboratory portion of the course will stress methodology development, isolation and characterization of microorganisms from natural and engineered systems, and examination of the roles of microorganisms in biogeochemical cycling.
Prerequisite(s): BIOL 2604
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: ENSC 4164

BIOL 4204 - Advanced Principles of Biology Teaching Assistant (3 credits)
For experienced Principles of Biology Undergraduate Teaching Assistants (UTAs) facilitating instruction of BIOL 1105 or 1106 class sections that utilize active-learning strategies. Collaboratively plan, present, and run activities to train first-time UTAs in the skills needed to support student success in the Principles of Biology classroom. Prepare first-time UTAs to guide active learning exercises, facilitate student teamwork, communicate scientific information, respond to student questions, provide feedback on student activities, and promote student engagement. Model professional and ethical conduct. Enrollment requires approval of Principles of Biology instructional team. May be repeated three times with different content for a maximum of nine credits. Pre: Senior standing.
Prerequisite(s): BIOL 3804
Instructional Contact Hours: (9 Lab, 3 Crd)
Repeatability: up to 9 credit hours

BIOL 4314 - Plant Ecology (4 credits)
Introduction to ecology of terrestrial plants including major plant functional types, ecophysiological aspects of functional types, molecular plant ecology, behavior of populations, responses of plant communities to disturbance, and vegetation analysis. Laboratory covers methods for measuring and analyzing natural vegetation, and setting up field and greenhouse experiments.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 3314) or HORT 2304
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4334 - Chemical Ecology (3 credits)
Chemical interactions between organisms with emphasis on the plant biosphere. Fundamental concepts, theories, and general methodology of chemical ecology: mechanisms of chemically- mediated interactions; and engineering of natural chemical defenses in sustainable agriculture.
Prerequisite(s): (BIOL 2304 or BIOL 2804 or FOR 2314 or BCHM 4115) and CHEM 1035
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4354 - Aquatic Entomology (4 credits)
Biology and taxonomy of insects and other macroinvertebrates most commonly encountered in freshwater environments. Selected aspects of biology, such as habitat, feeding, locomotion, and life history. Identification of individual taxa, mostly at family and genus level. Significance of these organisms in aquatic ecology, pollution monitoring, and natural resource management.
Prerequisite(s): (BIOL 1005 and BIOL 1006) and (BIOL 1015 and BIOL 1016) or (BIOL 1105 and BIOL 1106 and BIOL 1115 and BIOL 1116)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4354

BIOL 4404 - Ornithology (4 credits)
Biology of birds, including functional anatomy, systematics, evolutionary history, behavior, and ecology. Laboratory on systematics, anatomy, and field experience in the areas of behavior and ecology.
Prerequisite(s): BIOL 2804
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4454 - Invertebrate Zoology (4 credits)
Identification, morphology, evolutionary relationships, and natural history of free-living invertebrates, excluding insects.
Prerequisite(s): BIOL 2504
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

BIOL 4474 - Ethology (3 credits)
An evolutionary and ecological approach to animal behavior, drawing on behavioral genetics, endocrinology, neurophysiology, and behavioral ecology to explain how and why the behavior of an organism is adapted to its environment.
Prerequisite(s): BIOL 2504
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4484 - Freshwater Biomonitoring (4 credits)
Concepts and practices of using macroinvertebrates and fish to monitor the environmental health of freshwater ecosystems. Effects of different types of pollution and environmental stress on assemblages of organisms and underlying ecological principles. Role of biological studies in environmental regulation. Study design, field and laboratory methods, data analysis and interpretation, verbal and written presentation of results.
Prerequisite(s): (BIOL 2804) and (BIOL 4004 or BIOL 4354 or ENT 4354 or FIW 4424 or FIW 4614)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Course Crosslist: ENT 4484, FIW 4484

BIOL 4554 - Neurochemical Regulation (3 credits)
Neurochemical transmission within the vertebrate brain will be examined. Emphasis will be placed on the chemical coding underlying the control of various behaviors and how these systems can be modified by various drugs or diet.
Prerequisite(s): (ALS 2304 or BIOL 3404) and CHEM 2535
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4554

BIOL 4564 - Infectious Disease Ecology (3 credits)
Principles of infectious disease dynamics from ecological and evolutionary perspectives. Examines a variety of wildlife hosts and disease-causing agents (bacteria, viruses, and parasites) using the framework of agent-host- environment interactions. Selective coverage of specific host and pathogen models to illustrate underlying principles of wildlife disease emergence, maintenance, and spread, as well as connections between wildlife and human health.
Prerequisite(s): (BIOL 2704 or BIOL 2704H) and (BIOL 2804 or BIOL 2804H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4574 - Social Behavior of Birds and Mammals (3 credits)
This course examines origins, influences and implications of social behavior in a variety of avian and mammalian species. Emphasis is placed on understanding group organization and dynamics in inter and intra-species situations. Experimental data from several disciplines (e.g., genetics, physiology, biochemistry) are reviewed to demonstrate their associations with behavioral adaptive mechanisms. Avian and mammalian species living in wild, zoo, agricultural companion and laboratory settings are discussed.
Prerequisite(s): BIOL 1106 and ALS 3104 or BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4574

BIOL 4594 - Ecology, Evolution, and Behavior Senior Seminar (3 credits)
Review and discussion of contemporary research areas and global challenges addressed in publications in ecology, evolution, and behavior, the research process, methods for communicating science to professional and non-professional audiences, professional development for careers in ecology, evolution, and behavior, diversity and equity in the sciences.
Prerequisite(s): BIOL 2704 and BIOL 2804
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4624 - Microbial Genetics (3 credits)
Molecular genetics of bacteria and their associated plasmids and phages.
Prerequisite(s): BIOL 2004 and (BIOL 2604 or BIOL 2604H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4634 - Microbial Physiology (3 credits)
The study of the structure, function and metabolic activities of prokaryotic microorganisms. Topics covered included cell composition and growth, metabolic unity and diversity, patterns of regulation, transport mechanisms, environmental sensing and response and cellular differentiation processes. (BIOL 4624 is recommended, but not required.)
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4644 - Microbial Molecular Genetics and Physiology Laboratory (3 credits)
Introduction to classical and molecular methods used for the study of bacterial genetics and physiology. Laboratory exercises cover analysis of patterns of gene regulation; assay of enzymatic activities; mutagenesis followed by selection, screening, and physiological characterization of mutant strains; genome database utilization; and large scale fermentation.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4664 - Virology (3 credits)
Classification, structure, pathogenesis, host response, and replication strategies of viruses of bacteria, plants, and animals, stressing mechanisms elucidated by molecular biological techniques.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (2 Lec, 1 Lab, 3 Crd)

BIOL 4674 - Pathogenic Bacteriology (3 credits)
Characteristics of bacteria that cause human disease, nature of infectious processes, virulence factors, epidemiology, resistance, immunization.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4684 - Microbiomes (3 credits)
Landmark and current research on human microbiomes. Factors that influence the gut microbiome, and the role of the gut microbiome in disease. Other microbiomes of the human body. Bacteriophages and the ecology of microbiomes. Application of technologies to engineer microbiomes.
Prerequisite(s): BIOL 2004 and BIOL 2604 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4704 - Immunology (3 credits)
Immunochemistry of antigens and antibodies, serological reactions, chemistry of complement, control of immunity, immune response of an intact animal.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4714 - Immunology Laboratory (1 credit)
Serological and immunobiological techniques used to interpret the consequences of an immune response.
Prerequisite(s): BIOL 2134
Corequisite(s): BIOL 4704
Instructional Contact Hours: (3 Lab, 1 Crd)

BIOL 4724 - Pathogenic Bacteriology Lab (2 credits)
Microbiological techniques used to identify and characterize bacteria that cause infectious disease.
Prerequisite(s): BIOL 2134 and (BIOL 2604 or BIOL 2604H) and BIOL 2614
Corequisite(s): BIOL 4674
Instructional Contact Hours: (4 Lab, 2 Crd)

BIOL 4734 - Inflammation Biology (3 credits)
Cellular and molecular pathways controlling human responses to inflammatory challenges. Regulation of immune cells during inflammation. Interaction of host cells and tissues with environmental risk factors that cause inflammation. Pathogenesis of inflammatory diseases including cardiovascular diseases, diabetes, multi-organ failure, aging, neurological diseases and sepsis. Therapeutic intervention of inflammatory diseases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4774 - Molecular Biology Lab (3 credits)
An introduction to recombinant DNA methods, including restriction endonuclease digestion, gel electrophoresis, cloning, Southern blotting, polymerase chain reaction, sequencing and analysis of reporter gene expression in transgenic organisms. BIOL 3774 may be taken as a corequisite with 4774.
Prerequisite(s): BIOL 3774
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)

BIOL 4804 - Prokaryotic Diversity (3 credits)
The study of the vast array of physiological, morphological, and behavioral properties of prokaryotes. Topics include: modern prokaryotic classification, prokaryotic diversity, relationship and importance to cell and molecular biology and biochemistry, application and use in industry and agriculture, and to the maintenance of the biosphere. Must have pre-requisites or consent of the instructor.
Prerequisite(s): (BIOL 2604 or BIOL 2604H) and BIOL 2614 and (BIOL 3124 or BIOL 4634 or BCHM 3114)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4824 - Bioinformatics Methods (3 credits)
Application of bioinformatics methods in biological research. Methods to access bioinformatics data. Theory and methods for analysis of DNA sequences, and analysis of complex data sets including whole genome sequences and gene expression data. Use of standard bioinformatics software and databases.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4834 - Practical Analysis of Protein Structure and Function (3 credits)
Application of biophysical and biomechanical methods to characterization of protein structure and function, macromolecular interactions and conformational changes. Strategies, experimental design, practical considerations, troubleshooting, data analysis.
Prerequisite(s): BIOL 2134 and (CHEM 2536 or CHEM 2566) and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BIOL 4844 - Proteomics and Biological Mass Spectrometry (3 credits)
Introduction to mass spectrometry (MS) instrumentation and advanced proteomic methods for systems biology applications. Peptide mass fingerprinting, tandem MS, quantitation, phospho/glyco proteomics, and bioinformatics tools for evaluation and interpretation of mass spectrometry data.
Prerequisite(s): BIOL 2134 and CHEM 2535 and PHYS 2205
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4854 - Cytogenetics (3 credits)
Structure and function of eukaryotic chromosomes, with emphasis on (i) use of model systems to study specific chromosome substructures or functions; (ii) techniques used to identify and classify both normal and aberrant chromosomes; and (iii) diseases caused by defective chromosome structure and/or function.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4864 - Clinical Biology (3 credits)
Biological basis, development and symptoms of selected human diseases. Pharmacological approaches to treating disease. Review and interpretation of clinical cases. Approaches to working with patients: the interview, physical examination and clinical history. Use of diagnostic tests and treatments. Clinical trials of potential therapeutic interventions.
Prerequisite(s): BIOL 2134 and (BCHM 3114 or BCHM 4115)
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4874 - Cancer Biology (3 credits)
The molecular and cellular basis of cancer, including viral and cellular oncogenes, tumor suppression mechanics, cellular immortality, genomic integrity, angiogenesis, metastasis, and traditional and developing therapies.
Prerequisite(s): BIOL 2134
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4884 - Cell Biology (3 credits)
Advanced study of the inner workings of eukaryotic cells, including membrane structure and function, protein secretion, the cytoskeleton, cell cycle control and intercellular communication.
Prerequisite(s): BIOL 3774 or BCHM 4116
Instructional Contact Hours: (3 Lec, 3 Crd)

BIOL 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BIOL 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

BIOL 29844 - Special Study (1-18 credits)
Pathway Concept Area(s): 4 Reasoning in Natural Sci.
Instructional Contact Hours: (1-18 Lec, 1-18 Crd)

Biological Sciences Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2704	Evolutionary Biology [#]	3
BIOL 2804	Ecology [#]	3
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
Subtotal		20
Major Requirements		
BIOL 1004	Biology Orientation Seminar [2]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		19
Elective Courses		
Select 22 credits of Biological Sciences electives.		22
a. Select **at least one** of the following:		
BIOL 2304	Plant Biology [#]	
BIOL 2504	General Zoology [#]	
BIOL 2604	General Microbiology [#]	
b. Select **at least three** linked or inclusive laboratory courses from the list below (two must be BIOL or cross listed courses). Note: courses used to complete this requirement also count as Biological Sciences elective credits (section c).		
Linked Lab Courses [3]		
BIOL 2604 & BIOL 2614	General Microbiology and General Microbiology Laboratory [#]	
BIOL 3014 & BIOL 3024	Insect Biology and Insect Biology Laboratory [#]	
BIOL 3254 & BIOL 3264	Medical and Veterinary Entomology and Medical and Veterinary Entomology Laboratory [#]	
BIOL 4624 & BIOL 4644	Microbial Genetics and Microbial Molecular Genetics and Physiology Laboratory [#]	
BIOL 4674 & BIOL 4724	Pathogenic Bacteriology and Pathogenic Bacteriology Lab [#]	
BIOL 4704 & BIOL 4714	Immunology and Immunology Laboratory [#]	
CSES 3114 & CSES 3124	Soils and Soils Laboratory [#]	
NEUR 2025 & NEUR 2035	Introduction to Neuroscience and Neuroscience Laboratory [#]	
PSYC 4064 & PSYC 4264	Physiological Psychology and Laboratory in Physiological Psychology [#]	
Inclusive Lab Courses [3]		
BIOL 1135	Phage Hunters	
BIOL 1136	Phage Hunters [#]	
BIOL 3104	Cell and Molecular Biology Laboratory [#]	
BIOL 3114	[#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3514	Introduction to Histology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4314	Plant Ecology [#]	
BIOL 4354	Aquatic Entomology [#]	
BIOL 4404	Ornithology [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL 4484	Freshwater Biomonitoring [#]	
BIOL 4824	Bioinformatics Methods [#]	
FIW 4334	Mammalogy [#]	
FIW 4344	Herpetology [#]	

FIW 4424	Ichthyology [#, ^]
PPWS 4104	Plant Pathology [#]

c. Select **at least 12 credits at the 3000 or 4000 level** from the following list of Biological Sciences elective credits. A maximum of 9 credits of non-BIOL or non-cross listed courses from the list below may be counted toward the 22 required Biological Sciences elective credits.

BIOL 1024	Cancer: Causes, Treatments, Costs
BIOL 1034	Biology of Sex
BIOL 1054	Human Biology: Concepts and Current Issues
BIOL 1064	Plants and Civilization
BIOL 1074	How Animals Think
BIOL 1135	Phage Hunters
BIOL 1136	Phage Hunters [#]
BIOL 2304	Plant Biology [#]
BIOL 2404	Biotechnology in A Global Society [#]
BIOL 2504	General Zoology [#]
BIOL 2604	General Microbiology [#]
BIOL 2614	General Microbiology Laboratory [#]
BIOL 3014	Insect Biology [#]
BIOL 3024	Insect Biology Laboratory [#]
BIOL 3104	Cell and Molecular Biology Laboratory [#]
BIOL 3114	[#]
BIOL 3134	Human Genetics [#]
BIOL 3204	Plant Taxonomy [#]
BIOL 3254	Medical and Veterinary Entomology [#]
BIOL 3264	Medical and Veterinary Entomology Laboratory [#]
BIOL 3404	Introductory Animal Physiology [#]
BIOL 3454	Introductory Parasitology [#]
BIOL 3514	Introduction to Histology [#]
BIOL 3604	Food Microbiology [#]
BIOL 3774	Molecular Biology [#]
BIOL 3954	Study Abroad (var. credit)
BIOL 4004	Freshwater Ecology [#]
BIOL 4014	Environmental Toxicology [#]
BIOL 4104	Developmental Biology [#]
BIOL 4114	Global Change Ecology [#]
BIOL 4134	Evolutionary Genetics [#]
BIOL 4164	Environmental Microbiology [#]
BIOL 4314	Plant Ecology [#]
BIOL 4334	Chemical Ecology [#]
BIOL 4354	Aquatic Entomology [#]
BIOL 4404	Ornithology [#]
BIOL 4454	Invertebrate Zoology [#]
BIOL 4474	Ethology [#]
BIOL 4484	Freshwater Biomonitoring [#]
BIOL 4554	Neurochemical Regulation [#]
BIOL 4564	Infectious Disease Ecology [#]
BIOL 4574	Social Behavior of Birds and Mammals [#]
BIOL 4594	Ecology, Evolution, and Behavior Senior Seminar [#]
BIOL 4624	Microbial Genetics [#]
BIOL 4634	Microbial Physiology [#]
BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory [#]
BIOL 4664	Virology [#]
BIOL 4674	Pathogenic Bacteriology [#]
BIOL 4684	Microbiomes [#]
BIOL 4704	Immunology [#]
BIOL 4714	Immunology Laboratory [#]
BIOL 4724	Pathogenic Bacteriology Lab [#]
BIOL 4734	Inflammation Biology [#]
BIOL 4804	Prokaryotic Diversity [#]
BIOL 4824	Bioinformatics Methods [#]
BIOL 4844	Proteomics and Biological Mass Spectrometry [#]
BIOL 4854	Cytogenetics [#]
BIOL 4864	Clinical Biology [#]
BIOL 4874	Cancer Biology [#]
BIOL 4884	Cell Biology [#]
BIOL 4974	Independent Study (var. credit) [3]
BIOL 4994	Undergraduate Research [3]
ALS 2304	Comparative Animal Physiology and Anatomy [#]
ALS 3104	Animal Breeding and Genetics [#]
ALS 3204	Animal Nutrition and Feeding [#]
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [#]
CSES 3114	Soils [#]
CSES 3124	Soils Laboratory [#]
FIW 2314	Wildlife Biology [#, ^]
FIW 4334	Mammalogy [#]
FIW 4344	Herpetology [#]
FIW 4424	Ichthyology [#, ^]
FIW 4614	Fish Ecology [#]
FIW 4624	Marine Ecology [#]
FST 4634	Epidemiology Foodborne Disease [#]
NEUR 2025	Introduction to Neuroscience [#]
NEUR 2026	Introduction to Neuroscience [#]
NEUR 2035	Neuroscience Laboratory [#]
NEUR 2036	Neuroscience Laboratory [#]
PPWS 4104	Plant Pathology [#]
PPWS 4114	Microbial Forensics and Biosecurity [#]
PSYC 2064	Introduction to Neuroscience of Behavior [#]
PSYC 4064	Physiological Psychology [#]
PSYC 4264	Laboratory in Physiological Psychology [#]
Subtotal	22

Free Electives		
Select 14 credits		14
Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		

Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) [#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 design + 3 arts, or 6 integrated design/arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

Notes

[1] Students must earn a grade of "C" or better in BIOL 1105, 1106, 1115, 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

[2] BIOL 1004 is required but will not be used to calculate in-major GPA.

[3] A combined maximum of 4 credits of BIOL 4974 and/or BIOL 4994 taken A-F can be used toward Biological Sciences elective credit.

^ Course has major restriction: students may ask FiW to be added if seats are available.

[#] Some courses listed on this checksheet may have prerequisites; please consult the University Course Catalog or check with your advisor.

Cross listed Courses on this Checksheet

- NEUR/APSC 2025-2026: Introduction to Neuroscience
- BIOL/HORT 2304: Plant Biology
- ALS/BIOL 2404: Biotechnology in a Global Society
- ENT/BIOL 3014: Insect Biology
- ENT/BIOL 3024: Insect Biology Laboratory
- CSES/ENSC/GEOS 3114: Soils
- CSES 3124 / ENSC 3124 / GEOS 3624: Soils Laboratory
- ENT/BIOL 3254: Med & Vet Entomology
- ENT/BIOL 3264: Med & Vet Entomology Lab
- FST/BIOL 3604: Food Microbiology
- ENSC/BIOL 4164: Environmental Microbiology
- ENT/BIOL 4354: Aquatic Entomology
- ENT/FiW/BIOL 4484: Freshwater Biomonitoring
- ALS/BIOL 4554: Neurochemical Regulation
- ALS/BIOL 4574: Soc Behavior Birds & Mammals

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 upon attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biological Sciences elective credit, and all required CHEM, MATH, PHYS, and STAT courses will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biological Sciences elective credit, and all required CHEM, MATH, PHYS and STAT courses will be used to calculate in-major GPA.

BIOL majors who also are enrolled in the Microbiology major (no option) may count a maximum of 9 credits from the following courses toward the 22 required Biological Sciences elective credits: BIOL 3104, BIOL 3774, BIOL 3454, BIOL 3604, BIOL 4164, BIOL 4624, BIOL 4634, BIOL 4644, BIOL 4664, BIOL 4674, BIOL 4704, BIOL 4714, BIOL 4734, BIOL 4804, BIOL 4824, BIOL 4994, BCHM 3114, PPWS 4114, and FST 4634.

BIOL majors who also are enrolled in the Microbiology Biomedical option may count a maximum of 9 credits from the following courses toward the 22 required Biological Sciences elective credits: BIOL 3104, BIOL 3774, BIOL 3454, BIOL 3604, BIOL 4624, BIOL 4634, BIOL 4644, BIOL 4664, BIOL 4674, BIOL 4704, BIOL 4714, BIOL 4734, BIOL 4994, and BCHM 3114.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any -university approved First-Year Experience (FYE) course

BIOL 2704 Evolutionary Biology: BIOL 2704H

BIOL 2804 Ecology: BIOL 2804H

BIOL 4474 Ethology: PSYC 2074 Animal Behavior

BIOL 4994 Undergraduate Research: BIOL 2994 Undergraduate Research

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

NEUR 2025 Introduction to Neuroscience-NEUR 2026 Introduction to Neuroscience: APSC 2025 -APSC 2026

STAT 3615 Biological Statistics: STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Biological Sciences Major with Biology Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2704	Evolutionary Biology [#]	3
BIOL 2804	Ecology [#]	3
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
Subtotal		20
Major Requirements		
BIOL 1004	Biology Orientation Seminar [3]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		19
Option Required Courses		
BIOL 2304	Plant Biology [#]	3
BIOL 2504	General Zoology [#]	3
BIOL 2604	General Microbiology [#]	3
BIOL 2614	General Microbiology Laboratory [#]	1-2
BMSP 2135	Human Anatomy & Physiology [#]	3
GEOS 1014	Evolution of the Earth-Life System	3
Subtotal		16-17
Elective Courses		
Select at least 8 credits of Biological Sciences electives.		8
a. Linked or Inclusive Laboratory Courses		
Select **at least two** linked or inclusive laboratory courses of the following:		
BIOL 3014 & BIOL 3024	Insect Biology and Insect Biology Laboratory [#]	
BIOL 3104	Cell and Molecular Biology Laboratory [#]	
BIOL 3114	[#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3254 & BIOL 3264	Medical and Veterinary Entomology and Medical and Veterinary Entomology Laboratory [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4314	Plant Ecology [#]	
BIOL 4354	Aquatic Entomology [#]	
BIOL 4404	Ornithology [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL 4484	Freshwater Biomonitoring [#]	
BIOL 4624 & BIOL 4644	Microbial Genetics and Microbial Molecular Genetics and Physiology Laboratory [#]	
BIOL 4674 & BIOL 4724	Pathogenic Bacteriology and Pathogenic Bacteriology Lab [#]	
BIOL 4704 & BIOL 4714	Immunology and Immunology Laboratory [#]	
BIOL 4824	Bioinformatics Methods [#]	
b. Approved Biological Sciences Electives		
BIOL 1064	Plants and Civilization	
BIOL 1074	How Animals Think	
BIOL 2404	Biotechnology in A Global Society [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL 3014	Insect Biology [#]	
BIOL 3024	Insect Biology Laboratory [#]	
BIOL 3104	Cell and Molecular Biology Laboratory [#]	
BIOL 3114	[#]	

BIOL 3134	Human Genetics [#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3254	Medical and Veterinary Entomology [#]	
BIOL 3264	Medical and Veterinary Entomology Laboratory [#]	
BIOL 3404	Introductory Animal Physiology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 3774	Molecular Biology [#]	
BIOL 3954	Study Abroad (var. credit)	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4014	Environmental Toxicology [#]	
BIOL 4104	Developmental Biology [#]	
BIOL 4114	Global Change Ecology [#]	
BIOL 4134	Evolutionary Genetics [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4314	Plant Ecology [#]	
BIOL 4354	Aquatic Entomology [#]	
BIOL 4404	Ornithology [#]	
BIOL 4474	Ethology [#]	
BIOL 4484	Freshwater Biomonitoring [#]	
BIOL 4554	Neurochemical Regulation [#]	
BIOL 4564	Infectious Disease Ecology [#]	
BIOL 4574	Social Behavior of Birds and Mammals [#]	
BIOL 4594	Ecology, Evolution, and Behavior Senior Seminar [#]	
BIOL 4624	Microbial Genetics [#]	
BIOL 4634	Microbial Physiology [#]	
BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory [#]	
BIOL 4664	Virology [#]	
BIOL 4674	Pathogenic Bacteriology [#]	
BIOL 4684	Microbiomes [#]	
BIOL 4704	Immunology [#]	
BIOL 4714	Immunology Laboratory [#]	
BIOL 4724	Pathogenic Bacteriology Lab [#]	
BIOL 4734	Inflammation Biology [#]	
BIOL 4824	Bioinformatics Methods [#]	
BIOL 4844	Proteomics and Biological Mass Spectrometry [#]	
BIOL 4854	Cytogenetics [#]	
BIOL 4864	Clinical Biology [#]	
BIOL 4874	Cancer Biology [#]	
BIOL 4884	Cell Biology [#]	
BIOL 4974	Independent Study (var. credit) [2]	
BIOL 4994	Undergraduate Research (var. credit) [2]	
Subtotal		8
Free Electives		
Select 11-12 credits		11-12
Subtotal		11-12
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select 3 credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) [#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 design + 3 arts, or 6 integrated design/arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select 3 credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		120

Notes

[1] Students must earn a grade of "C" or better in BIOL 1105, 1106, 1115, 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

[2] A combined maximum of 4 credits of BIOL 4974 and/or BIOL 4994 Undergraduate Research taken as A-F can be used toward Option elective credit.

[3] BIOL 1004 Biology Orientation Seminar is required but will not count as major elective credit or be used to calculate in-major GPA.

[#] Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog, or check with your advisor.

Cross-listed Courses on this Checksheet

- BIOL/HORT 2304: Plant Biology
- ALS/BIOL 2404: Biotechnology in a Global Society
- ENT/BIOL 3014: Insect Biology
- ENT/BIOL 3024: Insect Biology Laboratory
- ENT/BIOL 3254: Med & Vet Entomology
- ENT/BIOL 3264: Med & Vet Entomology Lab
- FST/BIOL 3604: Food Microbiology
- ENSC/BIOL 4164: Environmental Microbiology
- ENT/BIOL 4354: Aquatic Entomology
- ENT/FiW/BIOL 4484: Freshwater Biomonitoring
- ALS/BIOL 4554: Neurochemical Regulation
- ALS/BIOL 4574: Soc Behav Birds & Mammals

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 upon attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biological Sciences elective credit, and all required CHEM, MATH, PHYS, and STAT courses will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biology Science Education Option elective credit, and all required CHEM, MATH, PHYS and STAT courses will be used to calculate in-major GPA.

Students must earn a grade of "C" or better in BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any university-approved First-Year Experience (FYE) course

BIOL 2704 Evolutionary Biology: BIOL 2704H

BIOL 2804 Ecology: BIOL 2804H

BIOL 4994 Undergraduate Research: BIOL 2994 Undergraduate Research

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors -CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

STAT 3615 Biological Statistics: STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Biological Sciences Major with Biomedical Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2704	Evolutionary Biology [#]	3
BIOL 2804	Ecology [#]	3
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
Subtotal		20
Major Requirements		
BIOL 1004	Biology Orientation Seminar [2]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		19
Option Required Courses		
BIOL 2604	General Microbiology [#]	3

BIOL 2614	General Microbiology Laboratory [#]	1-2
Subtotal		4-5
Option Electives [3]		
1. Basic Biomedical Elective		
Select two of the following:		6
BIOL 3514	Introduction to Histology [4, #]	
BIOL 3774	Molecular Biology [#]	
BIOL 4104	Developmental Biology [#]	
BIOL 4134	Evolutionary Genetics [#]	
BIOL 4664	Virology [4, #]	
BIOL 4684	Microbiomes [4, #]	
BIOL 4704	Immunology [4, #]	
BIOL 4824	Bioinformatics Methods [#]	
BIOL 4844	Proteomics and Biological Mass Spectrometry [#]	
BIOL 4884	Cell Biology [#]	
BIOL 4994	Undergraduate Research (A-F) [5]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [#]	
2. Biomedical Systems Elective		
Select two of the following:		6
BIOL 1054	Human Biology: Concepts and Current Issues	
BIOL 3134	Human Genetics [#]	
BIOL 3404	Introductory Animal Physiology [#]	
BIOL 3514	Introduction to Histology [4, #]	
BIOL 4554	Neurochemical Regulation [#]	
BIOL 4664	Virology [4, #]	
BIOL 4684	Microbiomes [4, #]	
BIOL 4704	Immunology [4, #]	
BIOL 4994	Undergraduate Research (A-F) [5]	
NEUR 2025	Introduction to Neuroscience [#]	
NEUR 2026	Introduction to Neuroscience [#]	
PSYC 2064	Introduction to Neuroscience of Behavior [#]	
PSYC 4064	Physiological Psychology [#]	
3. Disease Systems Elective		
Select two of the following:		6-7
BIOL 1024	Cancer: Causes, Treatments, Costs	
BIOL 3254	Medical and Veterinary Entomology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 4564	Infectious Disease Ecology [#]	
BIOL 4664	Virology [4, #]	
BIOL 4674	Pathogenic Bacteriology [#]	
BIOL 4684	Microbiomes [4, #]	
BIOL 4704	Immunology [4, #]	
BIOL 4734	Inflammation Biology [#]	
BIOL 4854	Cytogenetics [#]	
BIOL 4864	Clinical Biology [#]	
BIOL 4874	Cancer Biology [#]	
4. Laboratory Courses [6]		
Select two of the following:		2-7
BIOL 3104	Cell and Molecular Biology Laboratory [3]	
BIOL 3264	Medical and Veterinary Entomology Laboratory [3]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3514	Introduction to Histology [#]	
BIOL 4714	Immunology Laboratory [#]	
BIOL 4724	Pathogenic Bacteriology Lab [#]	
BIOL 4824	Bioinformatics Methods [#]	
NEUR 2035	Neuroscience Laboratory [#]	
Subtotal		20-26
Free Electives		
Select enough free elective courses to complete the requisite 120 total credit hours		12
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select 3 hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) [#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 hours = 3 design + 3 arts, or 6 integrated design/arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select 3 hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120-127**

1 Students must earn a grade of "C" or better in BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

2 BIOL 1004 is required but will not be used to calculate in-major GPA.

3 Biomedical Option students also enrolled in the Microbiology major (no option) may count a maximum of three of the following courses as Biomedical Option electives: BIOL 3774, BIOL 3454, BIOL 4664 Virology, BIOL 4674, BIOL 4704, BIOL 4734, BIOL 4824, BCHM 3114. Biomedical Option students also enrolled in the Microbiology Biomedical Option may count a maximum of two of the following courses as Biomedical Option electives: BIOL 3774, BIOL 3454, BIOL 4664, BIOL 4674, BIOL 4704, BIOL 4734, BCHM 3114.

4 A given elective course will count toward **only one** Biomedical Option Elective section.

[5] A 3-credit BIOL 4994 experience taken for grade of A-F may count **EITHER** toward Biomedical elective section 1 OR 2.

[6] A course listed as both a Biomedical Option Elective (either section 1, 2 or 3) and listed in the laboratory section (4) may count toward both that Biomedical Option Elective section and the laboratory course requirement.

Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog, or check with your advisor.

Cross listed Courses on this Checksheet

- ALS/BIOL 4554: Neurochemical Regulation
- ENT/BIOL 3254: Med & Vet Entomology
- ENT/BIOL 3264: Med & Vet Entomology Lab

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 upon attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biological Sciences elective credit, and all required CHEM, MATH, PHYS, and STAT courses will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biomedical Option elective credit, and all required CHEM, MATH, PHYS and STAT courses will be used to calculate in-major GPA.

Students must earn a grade of "C" or better in BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

Biomedical Option students also enrolled in the Microbiology major (no option) may count a maximum of three of the following courses as Biomedical Option electives: BIOL 3774, BIOL 3454, BIOL 4664, BIOL 4674, BIOL 4704, BIOL 4734, BIOL 4824, BCHM 3114. Biomedical Option students also enrolled in the Microbiology Biomedical Option may count a maximum of two of the following courses as Biomedical Option electives: BIOL 3774, BIOL 3454, BIOL 4664, BIOL 4674, BIOL 4704, BIOL 4734, BCHM 3114.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any university-approved First-Year Experience (FYE) course

BIOL 2704 Evolutionary Biology: BIOL 2704H

BIOL 2804 Ecology: BIOL 2804H

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors -CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

NEUR 2025 Introduction to Neuroscience-NEUR 2026 Introduction to Neuroscience: APSC 2025 -APSC 2026

STAT 3615 Biological Statistics: STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Biological Sciences Major with Ecology, Evolution, and Behavior Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1

BIOL 1116	Principles of Biology Laboratory [1]	1
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2704	Evolutionary Biology [#]	3
BIOL 2804	Ecology [#]	3
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
Subtotal		20
Major Requirements		
BIOL 1004	Biology Orientation Seminar [2]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		19
Option Electives [3]		
1. Organismal Diversity		
Select **one** of the following:		3
BIOL 2304	Plant Biology [#]	
BIOL 2504	General Zoology [#]	
BIOL 2604	General Microbiology [#]	
2. Organismal Biology, Behavior, and Physiology		
Select **at least 9 credits** of the following:		9
BIOL 1034	Biology of Sex	
BIOL 1074	How Animals Think	
BIOL 3014	Insect Biology [#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3404	Introductory Animal Physiology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 4354	Aquatic Entomology [#]	
BIOL 4404	Ornithology [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL 4474	Ethology [#]	
BIOL 4554	Neurochemical Regulation [#]	
BIOL 4574	Social Behavior of Birds and Mammals [#]	
BIOL 4994	Undergraduate Research (A-F) [4]	
FIW 4334	Mammalogy [#]	
FIW 4344	Herpetology [#]	
FIW 4424	Ichthyology [#, ^]	
3. Ecology and Evolution		
Select **at least 9 credits** of the following:		9
BIOL 1064	Plants and Civilization	
BIOL 3254	Medical and Veterinary Entomology [#]	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4014	Environmental Toxicology [#]	
BIOL 4114	Global Change Ecology [#]	
BIOL 4134	Evolutionary Genetics [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4314	Plant Ecology [#]	
BIOL 4334	Chemical Ecology [#]	
BIOL 4484	Freshwater Biomonitoring [#]	
BIOL 4564	Infectious Disease Ecology [#]	
BIOL 4594	Ecology, Evolution, and Behavior Senior Seminar [#]	
BIOL 4684	Microbiomes [#]	
BIOL 4824	Bioinformatics Methods [#]	
BIOL 4994	Undergraduate Research (A-F) [4]	
CSES 3114	Soils [#]	
FIW 4614	Fish Ecology [#]	
FIW 4624	Marine Ecology [#]	
4. Laboratory Courses		
Select **at least three** courses of the following: [3]		3-12
BIOL 2614	General Microbiology Laboratory [#]	
BIOL 3024	Insect Biology Laboratory [#]	
BIOL 3114	[#]	
BIOL 3204	Plant Taxonomy [#]	
BIOL 3264	Medical and Veterinary Entomology Laboratory [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 4004	Freshwater Ecology [#]	
BIOL 4314	Plant Ecology [#]	
BIOL 4354	Aquatic Entomology [#]	
BIOL 4404	Ornithology [#]	
BIOL 4454	Invertebrate Zoology [#]	
BIOL 4484	Freshwater Biomonitoring [#]	
BIOL 4824	Bioinformatics Methods [#]	
CSES 3124	Soils Laboratory [#]	
FIW 4334	Mammalogy [#]	
FIW 4344	Herpetology [#]	
FIW 4424	Ichthyology [#, ^]	
Subtotal		24-33
Free Electives		
Complete remaining credit hours to satisfy 120 credit hour requirement.		9-21
Subtotal		9-21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select 3 credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select 6 credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select 6 credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		

MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) #	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 design + 3 arts, or 6 integrated design/arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select 3 credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 Students must earn a grade of "C" or better in BIOL 1105, BIOL 1106, BIOL 1115, BIOL 1116, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

2 BIOL 1004 is required but will not be used to calculate in-major GPA.

3 A course used to complete the laboratory requirement may also count toward the EEB Elective group (2 or 3) in which it is listed.

4 A 3-credit BIOL 4994 experience taken for grade of A-F may count toward **EITHER** EEB Elective Option group 2 OR 3.

^ Course has major restriction: students may ask FIW to be added if seats are available.

Some courses listed on this checksheet may have prerequisites, please consult the University Course Catalog, or check with your advisor.

Cross-listed Courses on this Checksheet

- ALS/BIOL 4554: Neurochemical Regulation
- BIO/HORT 2304: Plant Biology
- ENSC/BIOL 4164: Environmental Microbiology
- CSES 3114 / GEOS 3614: Soils
- CSES 3124 / GEOS 3624: Soils Laboratory
- ENT/BIOL 3014: Insect Biology
- ENT/BIOL 3024: Insect Biology Laboratory
- ENT/BIOL 3254: Med and Vet Entomology
- ENT/BIOL 3264: Med and Vet Ent Lab
- ENT/BIOL 4354: Aquatic Entomology
- ENT/FIW/BIOL 4484: Freshwater Biomonitoring

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 after attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences), any course taken to fulfill Biological Sciences elective credit, and all required CHEM, MATH, PHYS, and STAT courses will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL courses (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, BIOL 3814 Careers In Biological Sciences), any course taken to fulfill EEB Option elective credit, and all required CHEM, MATH, PHYS and STAT courses will be used to calculate in-major GPA.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any university-approved First-Year Experience (FYE) course

BIOL 2704 Evolutionary Biology: BIOL 2704H

BIOL 2804 Ecology: BIOL 2804H

BIOL 4474 Ethology: PSYC 2074 Animal Behavior

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors -CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

STAT 3615 Biological Statistics: STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully

complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Microbiology Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2604	General Microbiology [1,#]	3
BIOL 2614	General Microbiology Laboratory [1,#]	1-2
BIOL 4624	Microbial Genetics [#]	3
BIOL 4634	Microbial Physiology [#]	3
BIOL 3764	Careers in Microbiology [#]	3
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [#]	3
Subtotal		22-23
Major Requirements		
BIOL 1004	Biology Orientation Seminar [3]	1
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		27
Elective Courses		
BIOL 3774 & BIOL 3104	Molecular Biology and Cell and Molecular Biology Laboratory [#]	3-4
or BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory	
BIOL 4674 & BIOL 4724	Pathogenic Bacteriology and Pathogenic Bacteriology Lab [#]	4-5
or BIOL 4704 & BIOL 4714	Immunology and Immunology Laboratory	
Select two of the following: (if not taken above)		8-9
BIOL 3254 & BIOL 3264	Medical and Veterinary Entomology and Medical and Veterinary Entomology Laboratory [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory [#]	
BIOL 4674 & BIOL 4724	Pathogenic Bacteriology and Pathogenic Bacteriology Lab [#]	
BIOL 4704 & BIOL 4714	Immunology and Immunology Laboratory [#]	
BIOL 4824	Bioinformatics Methods [#]	
BIOL 4994	Undergraduate Research [2]	
PPWS 4104	Plant Pathology [#]	
Select one of the following: (if not taken above)		3-4
BIOL 3254	Medical and Veterinary Entomology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4164	Environmental Microbiology [#]	
BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory [#]	
BIOL 4664	Virology [#]	
BIOL 4674	Pathogenic Bacteriology [#]	
BIOL 4684	Microbiomes [#]	
BIOL 4704	Immunology [#]	
BIOL 4734	Inflammation Biology [#]	
BIOL 4804	Prokaryotic Diversity [#]	
BIOL 4824	Bioinformatics Methods [#]	
BIOL 4994	Undergraduate Research [2]	
FST 4634	Epidemiology Foodborne Disease [#]	
PPWS 4104	Plant Pathology [#]	
PPWS 4114	Microbial Forensics and Biosecurity [#]	
Subtotal		18-22
Free Electives		
Select remaining credit hours to reach 120 required credit hours		3-8
Subtotal		3-8
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) [#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 design + 3 arts, or 6 integrated design/arts		6

Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total	**120**

Notes

[1] Students must earn a grade of "C" or better in BIOL 1105, 1106, 1115, 1116, 2604, 2614, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

[2] To count, students must complete two semesters of BIOL 4994 for a combined total of at least 4 credits.

[3] BIOL 1004 is required but will not count as major elective credit or be used to calculate in-major GPA.

[#] Some courses listed on this checksheet may have prerequisites; please consult the University Course Catalog or check with your advisor.

Cross listed Courses on this Checksheet

- ENSC/BIOL 4164: Environmental Microbiology
- ENT/BIOL 3254: Med & Vet Entomology
- ENT/BIOL 3264: Med & Vet Entomology Lab
- FST/BIOL 3604: Food Microbiology

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 upon attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL, MATH, and STAT courses, and all courses taken to fulfill Degree Core, Major, and Elective course requirements (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences) will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL, MATH, and STAT courses, and all courses taken to fulfill Degree Core, Major, and Elective course requirements (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences) will be used to calculate in-major GPA.

MICB students who are also enrolled as a BIOL (no option) student may count a maximum of 9 credits from the following courses toward the 22 required Biological Sciences elective credits: BIOL 3104, 3774, 3454, 3604, 4164, 4624, 4634, 4644, 4664, 4674, 4704, 4714, 4734, 4804, 4824, 4994, BCHM 3114, PPWS 4114, and FST 4634.

MICB students who are also enrolled as a Biomedical (BIOM) Option student may count a maximum of 3 courses from the following courses as Biomedical Option electives: BIOL 3774, 3454, 4664, 4674, 4704, 4734, 4824, BCHM 3114.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any university-approved First-Year Experience (FYE) course

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors -CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

STAT 3615 Biological Statistics:STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Microbiology Major with Biomedical Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
BIOL 2004	Genetics [#]	3
BIOL 2134	Cell Function and Differentiation [#]	3
BIOL 2604	General Microbiology [1,#]	3
BIOL 2614	General Microbiology Laboratory [1,#]	1-2
BIOL 4624	Microbial Genetics [#]	3
BIOL 4634	Microbial Physiology [#]	3
BIOL 3764	Careers in Microbiology [#]	3
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [#]	3
Subtotal		22-23
Major Requirements		
BIOL 1004	Biology Orientation Seminar [3]	1
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [#]	3
CHEM 2536	Organic Chemistry [#]	3
CHEM 2545	Organic Chemistry Laboratory [#]	1
CHEM 2546	Organic Chemistry Laboratory [#]	1
PHYS 2205	General Physics [#]	3
PHYS 2206	General Physics [#]	3
PHYS 2215	General Physics Laboratory [#]	1
PHYS 2216	General Physics Laboratory [#]	1
Subtotal		27
Elective Courses		
Select one of the following:		3-4
BIOL 3774 & BIOL 3104	Molecular Biology and Cell and Molecular Biology Laboratory [#]	
BIOL 4644	Microbial Molecular Genetics and Physiology Laboratory [#]	
Select Group 1 or Group 2		7-8
Group 1		
BIOL 4674	Pathogenic Bacteriology [#]	
BIOL 4724	Pathogenic Bacteriology Lab [#]	
BIOL 4704 or BIOL 4734	Immunology [#] Inflammation Biology	
Group 2		
BIOL 4704	Immunology [#]	
BIOL 4714	Immunology Laboratory [#]	
BIOL 4674	Pathogenic Bacteriology [#]	
Select two of the following: (if not taken above)		8-9
BIOL 3254 & BIOL 3264	Medical and Veterinary Entomology and Medical and Veterinary Entomology Laboratory [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4674 & BIOL 4724	Pathogenic Bacteriology and Pathogenic Bacteriology Lab [#]	
BIOL 4704 & BIOL 4714	Immunology and Immunology Laboratory [#]	
BIOL 4994	Undergraduate Research [2]	
Select one of the following: (if not taken above)		3-4
BIOL 3254	Medical and Veterinary Entomology [#]	
BIOL 3454	Introductory Parasitology [#]	
BIOL 3604	Food Microbiology [#]	
BIOL 4664	Virology [#]	
BIOL 4684	Microbiomes [#]	
BIOL 4704	Immunology [#]	
BIOL 4734	Inflammation Biology [#]	
BIOL 4874	Cancer Biology [#]	
BIOL 4994	Undergraduate Research [2]	
Subtotal		21-25
Free Electives		
Select remaining credit hours to reach 120 required credit hours		0-4
Subtotal		0-4
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F)	3
MATH 1026	Elementary Calculus (5F)	3
STAT 3615	Biological Statistics (5A) [#]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 design + 3 arts, or 6 integrated design/arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

Notes

[1] Students must earn a grade of "C" or better in BIOL 1105, 1106, 1115, 1116, 2604, 2614, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

[2] To count, students must complete two semesters of BIOL 4994 for a combined total of at least 4 credits.

[3] BIOL 1004 is required but will not count as major elective credit or be used to calculate in-major GPA.

[#] Some courses listed on this checksheet may have prerequisites; please consult the University Course Catalog or check with your advisor.

Cross listed Courses on this Checksheet

- ENT/BIOL 3254: Med & Vet Entomology
- ENT/BIOL 3264: Med & Vet Entomology Lab
- FST/BIOL 3604: Food Microbiology

1. Students must earn a grade of "C" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry or equivalent upon attempting 45 credit hours (including transfer credit, advance placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W"). Only two attempts are allowed for each course.
2. Students must achieve an overall GPA of 2.0 and in-major GPA of 2.2 upon attempting 45 credit hours (including transfer credit, advanced placement or IB credit, advance standing credit, credit by examination, courses taken P/F, and courses completed with a grade of "W").
3. All BIOL, MATH, and STAT courses, and all courses taken to fulfill Degree Core, Major, and Elective course requirements (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences) will be used to calculate in-major GPA.

Graduation Requirements

Students must have an in-major and overall GPA of 2.0 to graduate.

All BIOL, MATH, and STAT courses, and all courses taken to fulfill Degree Core, Major, and Elective course requirements (except BIOL 1004 Biology Orientation Seminar, BIOL 1214 Careers in Medicine, and BIOL 3814 Careers In Biological Sciences) will be used to calculate in-major GPA.

Students must earn a grade of "C" or better in BIOL 1105, 1106, 1115, 1116, 2604, 2614, CHEM 1035, CHEM 1036, or the equivalent. Only two attempts, including course withdrawals with grade of "W", are allowed for each course.

BIOL 1004 is required but will not count as major elective credit or be used to calculate in-major GPA.

MICM students who are also enrolled as a BIOL (no option) student may count a maximum of 9 credits from the following courses toward the 22 required Biological Sciences elective credits: BIOL 3104, 3774, 3454, 3604, 4624, 4634, 4644, 4664, 4674, 4704, 4714, 4734, 4994, and BCHM 3114.

MICM students who are also enrolled as a Biology-Biomedical (BIOM) Option student may count a maximum of two courses from the following courses as Biomedical Option electives: BIOL 3774, 3454, 4664, 4674, 4704, 4734, and BCHM 3114.

Acceptable Substitutions

BIOL 1004 Biology Orientation Seminar: Any university-approved First-Year Experience (FYE) course

CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors -CHEM 1056 General Chemistry for Chemistry Majors

CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry

CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab

PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics

PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics

MATH 1025 Elementary Calculus: MATH 1225 Calculus of a Single Variable

MATH 1026 Elementary Calculus: MATH 1226 Calculus of a Single Variable

STAT 3615 Biological Statistics: STAT 3005 Statistical Methods or STAT 3604 Statistics for Social Science

Foreign Language Requirement

College of Science Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Chemistry

Our Website (http://www.chem.vt.edu)

Overview

The Chemistry Department offers four undergraduate programs: the B.S. in Chemistry, the B.S. in Medicinal Chemistry, the B.S. in Polymer Chemistry, and the B.A. in Chemistry. The B.S. in Chemistry curriculum

provides the breadth and depth to give graduates a wide choice of career options, including further graduate studies. The Chemistry Department is accredited by the American Chemical Society's Committee on Professional Training and the B.S. Chemistry degree meets the guidelines for an ACS-certified degree. The B.S. in Medicinal Chemistry prepares students for enrollment in health professional schools or for careers in the pharmaceutical industry. The B.S. in Polymer Chemistry has a concentration in the area of polymer and material sciences. The B.A. program has fewer required chemistry courses, allowing students to design a chemistry program with more electives to meet a wider set of career goals. The B.A. is often chosen by students who wish to pursue a double major or to take other courses to prepare for professional school, law, or business. Any of the degrees are suitable to prepare for high school teaching. The Chemistry Department supports and encourages all chemistry majors to pursue undergraduate research sometime during their degree program.

Graduate Program

The Department offers M.S. and Ph.D. degrees with specializations in many areas of chemistry. (See the Graduate Catalog for further information.)

Minor Requirements

The requirements to earn a minor in Chemistry can be found on the specific checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html (https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html).

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Pathways to General Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.A. and B.S. in Chemistry, the B.S. in Medicinal Chemistry, and the B.S. in Polymer Chemistry can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Chemistry Major (B.A.) (p. 1249)
- Chemistry Major (B.S.) (p. 1250)
- Medicinal Chemistry Major (p. 1252)
- Polymer Chemistry Major (p. 1254)

Chair: A. J. Morris
Associate Chair: J. B. Matson
University Distinguished Professor: T. D. Crawford
Ethyl Corporation Chaired Professor: T. D. Crawford
Professors: D. Troya[7], H. C. Dorn, A. R. Esker, F. A. Etzkorn L. A. Madsen, J. B Matson, J. S. Merola[3,7], R. B. Moore, A. J. Morris, J. R. Morris, W. L. Santos, J. M. Tanko, and E. F. Valeev
Associate Professors: P. A. Deck, F. Lin, G. G. Liu, G. L. Long[3], N. Mayhall, B. M. Tissue, and G. T. Yee[7]
Assistant Professors: A. Figg, E. C. Gentry, D. Iovan, A. Lowell, E. Mevers, L. Quan, M. Schulz, V. V. Welborn, and J. C. Worch
Research Associate Professor: C. Slebodnick
Senior Instructors: S. M. Arachchige, M. A. Berg, M. B. Bump and J. E. Eddleton[3,4]
Advanced Instructor: V. K. Long
Instructors: A. Geller, N. J. McAlpine, K. Neidigh, E. B. Orler, C. Santos, A. Wagner, and C. Wall[4]
Assistant Professor of Practice: T. R. Saarinen
Director of Graduate Programs: A. R. Esker
Graduate Program Coordinator: J. Huynh
Director of Undergraduate Programs: P. A. Deck
Undergraduate Program Coordinator: A. Kokkinakos
Director of General Chemistry: S. M. Arachchige

Undergraduate Course Descriptions (CHEM)

CHEM 1004 - First Year Experience in Chemistry (1 credit)
Orientation to the Chemistry Department and to the discipline of chemistry for chemistry majors and for individuals considering CHEM as a major, including transfer students. Resources for success, both generally as a college student and specifically as a chemistry major. Opportunities for mentoring, individual research and community involvement across the university and within the Chemistry Department. Exploration of career pathways for chemistry majors. Interconnections among professional practice, disciplinary progress, accepted standards for ethical use of information, principles of diversity and inclusion, and individual or personal value systems. Scientific communication, professional networking, and chemistry in the public eye.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 1014 - Calculations in Chemistry (3 credits)
Mathematical problem solving skills required for success in general chemistry. Manipulation of symbolic algebraic formulas. Dimensional analysis and narrative mathematical exercises. Application of problem solving techniques to chemical processes and reactions. Generation and interpretation of graphs using computer software. Elementary features of atoms, molecules, and the periodic table of the elements. Molar quantities, chemical nomenclature, reaction stoichiometry, and introductory solution chemistry.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1015 - Chemistry in Context (3 credits)
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1016 - Chemistry in Context (3 credits)
Survey of chemistry across areas of specialization for students enrolled in curricula other than science and engineering. History and fundamental concepts and theories of chemistry, including the consequences of changes in parameters on chemical systems. Impact of chemistry in the context of areas of public concern and policy, including best practices for sustainability, rational decision-making, ethical use of scientific information, product and process stewardship. Chemistry as a basis for decision-making in the context of individual values and beliefs, and the roles of values and beliefs in the progress of chemistry as a human endeavor. The foregoing to be based on the concepts of chemistry as follows: 1015: Periodicity and atomic structure; nuclear chemistry; chemical bonding and reactivity; organic chemistry, polymer chemistry, and medicinal chemistry. 1016: Chemical stoichiometry including conservation of matter and energy; acid-base and oxidation-reduction chemistry of solutions; stoichiometry and thermodynamics, agricultural and environmental chemistry, chemistry of household and personal care products
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1025 - Introduction to Chemistry Laboratory (1 credit)
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical consequences of decision- making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1026 - Introduction to Chemistry Laboratory (1 credit)
Virtual laboratory exercises and reading and writing assignments designed to accompany 1015 and 1016, as applicable. Illustrates and elaborates on principles addressed in lecture, including history and fundamental concepts, theories, contexts, with an emphasis on sustainability issues and ethical consequences of decision- making in chemistry. Students will identify foundational concepts in chemistry, enumerate parameters likely to influence the outcome of an experiment, analyze the ways that values and beliefs influence progress in the discipline and communicate chemical concepts to a lay audience.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1034 - General Chemistry Recitation (1 credit)
A companion course for students needing supplemental help with mathematical and problem-solving skills required for CHEM 1035 General Chemistry. Manipulation of algebraic formulas. Application of problem-solving techniques to chemical processes and reactions. Quantitative methods applied to unit conversions, reaction yields, energy of reactions, and gas properties. Examination of atomic structure, periodicity, and molecular bonding. May not count towards degree requirements; consult advisor. Pass/Fail only.
Corequisite(s): CHEM 1035
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 1035 - General Chemistry (3 credits)
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student's own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Properties of the three states of matter alone and in mixtures, kinetics, aqueous equilibrium, thermodynamics, electrochemistry. (Duplicates 1015-1016.) Students may bypass prerequisites for 1035 through testing alternatives listed in the Registrar's Timetable.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214 or MATH 1524
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1036 - General Chemistry (3 credits)
First chemistry course for students in science curricula. Applications of reasoning in the natural sciences using chemical laws in an applied context and in the student's own discipline. Overview of the universal aspects of chemistry and of application of chemistry to address global challenges. 1035: Problem-solving, elements and periodic table, stoichiometry of chemical reactions, gas phase of matter, energy flow and chemical change, atomic structure, and theories of chemical bonding. 1036: Properties of the three states of matter alone and in mixtures, kinetics, aqueous equilibrium, thermodynamics, electrochemistry. (Duplicates 1015-1016.) Students may bypass prerequisites for 1035 through testing alternatives listed in the Registrar's Timetable.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1055H
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 1045 - General Chemistry Laboratory (1 credit)
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214 or MATH 1524
Corequisite(s): CHEM 1035
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1046 - General Chemistry Laboratory (1 credit)
Hands-on, real-world activities that illustrate and elaborate on concepts taught in general chemistry lecture (1035-1036), including acids and bases, heat capacity, ideal gases, states of matter, concentration, mixtures, energy flow and spontaneity in processes, equilibrium, kinetics, colligative properties, and electrochemistry. Use of instrumentation to analyze water and soil contaminants, biofuel mixtures, nanoparticles, and polymer properties. Laboratory safety, chemical hygiene, hazard mitigation, waste management, and the influence of procedure on experimental outcomes. Global challenges, including recycling and sustainable energy sources, water resource management, global warming, and environmentally friendly reagents in chemical contexts. Use of computers in data analysis, collaboration, and report-writing.
Prerequisite(s): CHEM 1045 or CHEM 1065
Corequisite(s): CHEM 1036
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1055 - General Chemistry for Chemistry Majors (4 credits)
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 1056 - General Chemistry for Chemistry Majors (4 credits)
In depth treatment of chemical bonding, thermodynamics, chemical equilibrium, reaction kinetics, descriptive chemistry of the elements, acid-base chemistry, chemistry of gases, liquids and solids, and other topics. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1055 or CHEM 1055H
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 1065 - General Chemistry for Chemistry Majors Lab (1 credit)
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1014 or MATH 1014 or MATH 1025 or MATH 1536 or MATH 1225 or MATH 1214
Corequisite(s): 1055 or 1055H.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 1066 - General Chemistry for Chemistry Majors Lab (1 credit)
Accompanies 1055-1056. Selected experiments illustrate principles taught in lecture. This class is restricted to chemistry and biochemistry majors. Other students may request consent of instructor.
Prerequisite(s): CHEM 1065
Corequisite(s): 1056 or 1056H.
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2114 - Analytical Chemistry (3 credits)
A first course in analytical chemistry. Topics covered include volumetric and gravimetric analysis, and elementary spectroscopy.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H
Corequisite(s): CHEM 2124
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2124 - Analytical Chemistry Laboratory Techniques and Practice (1 credit)
Practical introduction to wet methods of quantitative chemical analysis based on fundamental chemical principles. Prior credit for OR concurrent registration of 2114 lecture is required for 2124 lab.
Prerequisite(s): CHEM 1046 or CHEM 1066
Corequisite(s): CHEM 2114
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2154 - Analytical Chemistry for Chemistry Majors (4 credits)
A one-semester course in analytical chemistry emphasizing the principles of equilibrium with examples from acid-base, complexation, solubility, and redox chemistry. The course also introduces the principles of spectroscopic, electrochemical, and chromatographic instrumentation.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106
Corequisite(s): CHEM 2164
Instructional Contact Hours: (4 Lec, 4 Crd)

CHEM 2164 - Analytical Chemistry for Chemistry Majors Lab (1 credit)
A one-semester laboratory course in analytical chemistry that provides practical training in wet chemical methods, atomic and molecular spectroscopy, electrochemistry, and separations.
Prerequisite(s): CHEM 1046 or CHEM 1066 or ISC 1116
Corequisite(s): CHEM 2154
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2424 - Descriptive Inorganic Chemistry (3 credits)
Application of fundamental principles in a systematic study of bonding and reactivity of the elements and their compounds.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2514 - Survey of Organic Chemistry (3 credits)
Short course in fundamentals of organic chemistry with emphasis on nomenclature, isomerism, and properties of organic compounds. Compounds of importance to biology and biochemistry stressed. (Prior credit for 2535 precludes credit for this course.) One year of Chemistry required.
Prerequisite(s): (CHEM 1035 or CHEM 1055 or CHEM 1055H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2535 - Organic Chemistry (3 credits)
Structure, stereochemistry, reactions, and synthesis of organic compounds.
Prerequisite(s): CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106 or ISC 1106H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2536 - Organic Chemistry (3 credits)
Structure, stereochemistry, reactions, and synthesis of organic compounds. Pre: One year of chemistry, including lab.
Prerequisite(s): CHEM 2535 or (CHEM 2565 or CHEM 2565H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2545 - Organic Chemistry Laboratory (1 credit)
The laboratory accompanies lectures in organic chemistry 2535 and 2536.
Prerequisite(s): CHEM 1046 or CHEM 1065 or ISC 1116
Corequisite(s): CHEM 2535, CHEM 2565
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2546 - Organic Chemistry Laboratory (1 credit)
The laboratory accompanies lectures in organic chemistry 2535 and 2536.
Prerequisite(s): CHEM 2545
Corequisite(s): CHEM 2536
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 2555 - Organic Synthesis and Techniques Lab (2 credits)
Synthesis and characterization of organic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 1045 or CHEM 1065
Corequisite(s): CHEM 2565
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 2556 - Organic Synthesis and Techniques Lab (2 credits)
Synthesis and characterization of organic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 2555
Corequisite(s): CHEM 2566
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 2564 - Problem-Solving in Organic Chemistry (1 credit)
Writing organic reaction mechanisms; rationalizing and predicting organic reaction outcomes; selecting reagents for organic reactions; designing syntheses of several elementary steps; visualizing molecular stereochemistry.
Corequisite(s): CHEM 2565
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 2565 - Principles of Organic Chemistry (3 credits)
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1035H or CHEM 1055H
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2566 - Principles of Organic Chemistry (3 credits)
Organic chemistry for chemistry majors. Structure and reactions of organic compounds, with emphasis on fundamental principles, theories, synthesis, and reaction mechanisms. The subject matter partially duplicates that of 2535-2536; no credit will be given for the duplicated courses.
Prerequisite(s): CHEM 2565
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

CHEM 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 3004 - Bridge to the Future (1 credit)
Exploration and development of post-baccalaureate career options, including non-traditional options, for chemistry students. Opportunities in the government, private and academic sectors. Career planning. Managing application processes for graduate school, professional school, and employment. Development of materials (resumes, cover letters, portfolios, and personal statements) needed for applications. Fellowships and scholarships for graduate study. Opportunities for career-relevant experience before graduation. Integrity in career development. Open to majors in Chemistry, Medicinal Chemistry, and Polymer Chemistry.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 3054 - Postconsumer Materials (3 credits)
Chemistry and global impacts of postconsumer materials including trash, biodegradable, recyclable, and reusable materials. Waste management of metals, ceramics, and polymers in the context of their chemical properties. Reliability and accuracy of information sources on postconsumer materials. Complex contemporary issues involving disposal and repurposing of postconsumer materials including health impacts, energy, cost, water quality, return value, and environmental and cultural considerations.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3615 - Physical Chemistry (3 credits)
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4615, cannot receive credit for both 3615 and 4615.
Prerequisite(s): (CHEM 1035 or CHEM 1055 or CHEM 1055H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 2204 or MATH 2204H or MATH 2224)
Corequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3616 - Physical Chemistry (3 credits)
Principles of thermodynamics, kinetics, and quantum mechanics applied to chemical equilibria, reactivity, and structure. Partly duplicates 4616, cannot receive credit for both 3616 and 4616.
Prerequisite(s): MATH 2214 and (CHEM 3615 or CHEM 3615H)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 3625 - Physical Chemistry Laboratory (1 credit)
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed.
Prerequisite(s): CHEM 3615 or CHEM 3615H or CHEM 4615 or CHE 2164
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 3626 - Physical Chemistry Laboratory (1 credit)
Laboratory study of selected physico-chemical principles and methods. Data acquisition, data analysis, and report writing are stressed. I
Prerequisite(s): (CHEM 3616 or CHEM 3616H or CHEM 4616) and CHEM 3625 and CHEM 4014
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 3684 - Quantum Software I (2 credits)
Organization of quantum information (assemblies of bits) for quantum-computing applications in chemistry, physics, biology, and computer science. Numerical methods for quantum software, emphasizing spin lattices and simulations such as quantum games. Best practices for programming, including techniques for quantum-coding (in Python or Julia), structuring a software product for quantum-computational science use, version control, and cloud-based documentation and code-sharing (via Github). Classical/quantum translation.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 3144
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: PHYS 3684

CHEM 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

CHEM 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4014 - Survey of Chemical Literature (1 credit)
Use of the chemical literature as an aid to professional activities. Pre: Junior Major Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

CHEM 4034 - Capstone Laboratory for BA Chemistry Majors (2 credits)
A senior-level laboratory course that integrates previous laboratory and lecture experiences to illustrate the interconnectedness of the curriculum leading to the BA in Chemistry. Modern experimental methods and instrumentation, including chromatographic separations, nuclear magnetic resonance, infrared spectrometry, and mass spectrometry. Independent experimental design and execution of an experimental synthetic reaction in chemistry, including scaling, selection of reagents and solvents, and development of a procedure for completing the reaction, isolating the product, and characterizing it for structure and bulk purity. Best practices in lab safety, chemical hygiene, note-keeping, and professional report-writing. Principles of green chemistry. Pre: Senior standing.
Prerequisite(s): CHEM 2164 and (CHEM 2546 or CHEM 2566)
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4074 - Laboratory in Polymer Science (2 credits)
Experimental techniques used in the synthesis of various linear polymers, copolymers, and crosslinked networks. Determination of polymer molecular weights and molecular weight distribution. Methods used in the thermal, mechanical, and morphological characterization of polymeric systems.
Prerequisite(s): CHEM 4534 and CHEM 3625 and (CHEM 3615 or CHE 2164)
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)
Course Crosslist: MSE 4544

CHEM 4114 - Instrumental Analysis (3 credits)
Principles of instrumental methods including data analysis, phase equilibrium, spectroscopy, and electrochemistry. Applications of modern instrumentation to chemical analyses using chromatography, electrophoresis, atomic and molecular spectroscopy, potentiometry, and voltammetry. Note: Graduate students will not be expected to take the corequisite lab 4124.
Prerequisite(s): CHEM 2154
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4124 - Instrumental Analysis Laboratory (1 credit)
Hands-on experience with modern instrumental methods of analysis. Experiments use spectroscopy, electrochemistry, and separations.
Prerequisite(s): CHEM 4114
Instructional Contact Hours: (3 Lab, 1 Crd)

CHEM 4404 - Physical Inorganic Chemistry (3 credits)
A study of spectroscopic, bonding, and structural properties of inorganic compounds.
Prerequisite(s): (CHEM 3616 or CHEM 3616H) and CHEM 2424
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4414 - Inorganic Chemistry Lab (2 credits)
Synthesis and characterization of inorganic compounds using modern laboratory techniques.
Prerequisite(s): CHEM 2424 and (CHEM 3616 or CHEM 3616H) and CHEM 4404
Corequisite(s): CHEM 3616, CHEM 4424
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4424 - Polysaccharide Chemistry (3 credits)
Structure, properties, and applications of natural polysaccharides. Natural sources and methods of isolation. Synthetic chemistry and important polysaccharide derivatives. Relation of structure and properties to performance in critical applications including pharmaceuticals, coatings, plastics, rheology control, and films. Conversion by chemical and biochemical methods of polysaccharide biomass to fuels and materials.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: SBIO 4424

CHEM 4434 - Organometallic Chemistry (3 credits)
Synthesis, structure, properties, and reactivity patterns of main-group and transitionmetal organometallic compounds. Applications of organometallic compounds in chemical synthesis and catalysis.
Prerequisite(s): CHEM 2424 and CHEM 2565 and CHEM 2566 and CHEM 4404
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4444 - Bioinorganic Chemistry (3 credits)
Principles underpinning the study of metal ions in biological systems. Review of basic coordination chemistry. Evolution of the distribution of metal ions in biology. Uptake of metal ions from the environment into living organisms. Regulation of metal ion concentrations in cells. Central functions of metal ions in biological systems including modulation of structure, electron transfer reactions, substrate binding and activation, and selective transfer of atoms and groups. Roles of biopolymers in the binding, regulation, and function of metal ions. Physical methods of analysis relevant to bioinorganic chemical research questions. Senior standing.
Prerequisite(s): (CHEM 2566 or BCHM 4115) and BIOL 1105 and BIOL 1106
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4514 - Green Chemistry (3 credits)
Sustainability, waste prevention, conservation of energy resources, avoidance of toxins, pollutants, and hazards in chemical processes and products. Life-cycle analysis applied to case studies involving process development and product stewardship. Applications in chemical industry, process and product design, and public policy.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4524 - Identification of Organic Compounds (3 credits)
Structure determination of organic compounds by spectroscopic methods. Interpretation of 1H and 13C nuclear magnetic resonance (NMR) spectra including two-dimensional (2D) spectra. Mass spectrometric (MS) techniques including tandem MS. Selection and application of minor organic-analytical techniques for structure elucidation. Formatting of spectroscopic data for publication. Course credit will not be awarded for both CHEM 4524 and CHEM 5524G.
Prerequisite(s): (CHEM 2536 or CHEM 2566) and (CHEM 3616 or CHEM 4616)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4534 - Organic Chemistry of Polymers (3 credits)
Structure, synthesis, and basic characteristics of the major classes of polymerization reactions including step-growth (condensation) and chain growth (addition), free radical, and ionic mechanisms.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4544 - Medicinal Chemistry Capstone Laboratory (2 credits)
Laboratory experience tracing a standard pathway that potential drug targets follow in many medicinal chemistry laboratories. Synthesis of potential drug compounds and verification of their purity and structural identity primarily using mass spectrometry and nuclear magnetic resonance (NMR) spectroscopy. Optimization of conditions for a biochemical assay and verification of its reproducibility. Use of an optimized assay to measure the potency of potential drug compounds to achieve a desired biochemical effect. Application of structure-activity relationships to propose new chemical structures that might show further improvements in potency. Best practices in laboratory safety, chemical hygiene, note-keeping, and professional report-writing. Senior standing.
Prerequisite(s): CHEM 4584 and BIOL 1105 and BIOL 1106
Instructional Contact Hours: (6 Lab, 2 Crd)

CHEM 4554 - Drug Chemistry (3 credits)
Structure, synthesis, and physiological effects of major classes of pharmaceutical agents including CNS depressants and stimulants, analgesics, anesthetics, cardiovascular agents, chemotherapeutic drugs, and oral contraceptives.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4584 - Bioorganic Chemistry (3 credits)
The organic chemistry underlying the structure and properties of amino acids, peptides, and nucleic acids. Mechanisms of enzyme catalysis and coenzyme-mediated reactions. Mechanisms and thermodynamics of catabolism and anabolism of fats, carbohydrates, and proteins, and of other key biological reactions. Principles of solid-phase synthesis applied to peptides and nucleic acids. Biosynthesis of lipids, sugars, and terpenoids.
Prerequisite(s): CHEM 2536 or CHEM 2566
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4615 - Physical Chemistry for the Life Sciences (3 credits)
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3615, cannot receive credit for 3615 and 4615.
Prerequisite(s): ISC 2106H or (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 1026 or MATH 1226)
Corequisite(s): PHYS 2206 or PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4616 - Physical Chemistry for the Life Sciences (3 credits)
Principles of thermodynamics, chemical kinetics, and chemical bonding for students in the life sciences. 4615: Laws and applications of thermodynamics. 4616: Chemical kinetics and chemical bonding including spectroscopy. Partly duplicates 3616, cannot receive credit for both 3616 and 4616.
Prerequisite(s): ISC 2106H or (CHEM 1036 or CHEM 1056 or CHEM 1056H) and (MATH 1026 or MATH 1226) and (PHYS 2206 or PHYS 2306)
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4624 - Materials Chemistry in Energy Sciences (3 credits)
Fundamental principles of solid-state materials chemistry in energy sciences. Thermodynamics and kinetics of electron and ion transport in solid materials. Application of electrochemical and photochemical principles to batteries, fuel cells, solar cells, and other energy devices. Analytical tools and characterization methods for elucidating mechanisms within electrochemical and photoelectrochemical cells, with an emphasis on using electrochemical principles to evaluate battery chemistry. Solid-liquid interfacial mechanisms in energy devices. Critical analysis of relevant primary literature. Formulation of hypotheses and experimental design for improving device performance. Pre: Senior standing.
Prerequisite(s): CHEM 3615 or CHEM 4615
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4634 - Polymer and Surface Chemistry (3 credits)
Physical chemical fundamentals of polymers and surfaces including adhesives and sealants.
Prerequisite(s): CHEM 3615 or CHEM 4615
Instructional Contact Hours: (3 Lec, 3 Crd)

CHEM 4684 - Quantum Software II (1 credit)
Modern software collaboration techniques and tools including collaborative code repositories and cloud-based documentation. Application of structure and version control to software and documentation. Developing code with industry-standard quantum-software modules. Hands-on scientific coding for quantum problems. Project management skills including proposal development and technical presentation delivery.
Prerequisite(s): CHEM 3684 or PHYS 3684
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: PHYS 4684

CHEM 4734 - Environmental Soil Chemistry (3 credits)
Chemistry of inorganic and organic soil components with emphasis on environmental significance of soil solution-solid phase equilibria, sorption phenomena, ion exchange processes, reaction kinetics, redox reactions, and acidity and salinity processes.
Prerequisite(s): CSES 3114 or ENSC 3114 or GEOS 3614 and CSES 3124 or ENSC 3124 or GEOS 3624 and CHEM 2514 or CHEM 2535 and CHEM 2114 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENSC 4734

CHEM 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

CHEM 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CHEM 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Chemistry Major (B.A.)

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1004	First Year Experience in Chemistry	1
CHEM 1055	General Chemistry for Chemistry Majors [1,2]	4
CHEM 1056	General Chemistry for Chemistry Majors [1,2]	4
CHEM 1065	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 1066	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 2565	Principles of Organic Chemistry [1,4]	3
CHEM 2566	Principles of Organic Chemistry [1,4]	3
CHEM 2154	Analytical Chemistry for Chemistry Majors [1]	4
CHEM 2164	Analytical Chemistry for Chemistry Majors Lab [1]	1
Subtotal		22
Additional Course Requirements [5]		
CHEM 2545	Organic Chemistry Laboratory [4]	1
CHEM 2546	Organic Chemistry Laboratory [4]	1
CHEM 2564	Problem-Solving in Organic Chemistry	1
CHEM 3004	Bridge to the Future	1
CHEM 4014	Survey of Chemical Literature	1
Subtotal		5
Major Requirements		
CHEM 2424	Descriptive Inorganic Chemistry	3
CHEM 4615	Physical Chemistry for the Life Sciences [6]	3
CHEM 4616	Physical Chemistry for the Life Sciences [7]	3
CHEM 3625	Physical Chemistry Laboratory	1
CHEM 4034	Capstone Laboratory for BA Chemistry Majors [8]	2
Subtotal		12
Restricted Electives		
Students may choose any two 3-credit, 3000- or 4000-level courses in CHEM, BCHM, or CHE for which they have met applicable prerequisites. [9,10,11]		6
Subtotal		6
Free Electives		
Select remaining credit hours of free electives to fulfill 120 credit hour requirement		28
Subtotal		28
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) (foundational writing or speaking courses) and three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (advanced or applied writing or speaking courses).		9
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits of Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [12]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory [1,13]	4
PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory [1,14]	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [1,15]	3
MATH 1026	Elementary Calculus (5F) [1,16]	3
STAT 3005	Statistical Methods (5A) [1,17]	3
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
6 credits = 3 in design + 3 in arts, or 6 in integrated design and arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 A course with prerequisites or co-requisites.

2 *General Chemistry Lecture Substitutions*. A student who earned credit for CHEM 1035 with a grade of"B" or better prior to joining the major in Chemistry may substitute CHEM 1035 for CHEM 1055. A student who earned credit for CHEM 1036 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1036 for CHEM 1056.

3 *General Chemistry Lab Substitutions*. A student who earned credit for CHEM 1045 prior to joining the major in Chemistry may substitute CHEM 1045 for CHEM 1065. A student who earned credit for CHEM 1046 prior to joining the major in Chemistry may substitute CHEM 1046 for CHEM 1066.

4 *Organic Chemistry Substitutions*. Lecture: A student who earned credit for CHEM 2535 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2535 for CHEM 2565. A student who is substituting CHEM 2535 for CHEM 2565 may also substitute one additional credit of free elective for the one credit CHEM 2564, since CHEM 2564 is meant as a companion course to CHEM 2565. A student who earned credit for CHEM 2536 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2536 for CHEM CHEM 2566. Lab: CHEM 2555 may be substituted for CHEM 2545. CHEM 2556 may be substituted for CHEM 2546.

5 MATH 1025–MATH 1026, PHYS 2205–PHYS 2206 and PHYS 2215–PHYS 2216 are also required of all Chemistry Majors

within the B.A. Degree Program in Chemistry. They are listed in the Pathways to General Education section.

6 CHEM 3615 may be substituted for CHEM 4615.

7 CHEM 3616 may be substituted for CHEM 4616.

8 Three (3) credits of CHEM 4994 may be substituted for CHEM 4034.

9 Excluding CHEM 3054 Postconsumer Materials

10 SBIO 3444 or CHEM 4424 (SBIO 4424) may substitute for the Restricted Elective.

11 A chemistry major (BA) may count at most three (3) credits of CHEM 4994 toward the total credits for Restricted Electives. A biochemistry or chemical engineering student should not double-count coursework required for that major towards the chemistry (BA) upper-level total credits for Restricted Electives.

12 PSYC 1004 and SOC 1004 are recommended for students contemplating careers in health sciences.

13 PHYS 2305 (MATH 1225 prerequisite) may be substituted for PHYS 2205 and PHYS 2215

14 PHYS 2306 (MATH 1226 prerequisite) may be substituted for PHYS 2206 and PHYS 2216

15 MATH 1225 may be substituted for MATH 1025.

16 MATH 1226 (MATH 1225 prerequisite) may be substituted for MATH 1026.

17 Students majoring in Chemistry within the B.A. Degree in Chemistry must select either STAT 3005 or STAT 3615.

Satisfactory Progress Towards Degree

Upon having attempted 72 credits, student must have completed

Code	Title	Credits
CHEM 1055	General Chemistry for Chemistry Majors	4
CHEM 1056	General Chemistry for Chemistry Majors	4
CHEM 1065	General Chemistry for Chemistry Majors Lab	1
CHEM 1066	General Chemistry for Chemistry Majors Lab	1
CHEM 1004	First Year Experience in Chemistry	1
CHEM 2565	Principles of Organic Chemistry	3
CHEM 2566	Principles of Organic Chemistry	3
CHEM 2545	Organic Chemistry Laboratory	1
CHEM 2546	Organic Chemistry Laboratory	1
PHYS 2205	General Physics	3
PHYS 2206	General Physics	3
PHYS 2215	General Physics Laboratory	1
PHYS 2216	General Physics Laboratory	1
MATH 1025	Elementary Calculus	3
MATH 1026	Elementary Calculus	3

Chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Graduation Requirements

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes CHEM 1015, CHEM 1016, CHEM 1025, CHEM 1026, CHEM 1004, CHEM 1014. No more than 6 hours of CHEM 2974, CHEM 4974, and CHEM 4994 will be included in a student's in-major GPA.

Minimum Grade Requirement

- A Chemistry major who earned a grade lower than "C" in CHEM 1055 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1035 and earn a grade of "B" or better.
- A Chemistry major who earned a grade lower than "C" in CHEM 1056 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1036 and earn a grade of "B" or better
- A Chemistry major who earned a grade lower than "C" in CHEM 2565 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 2535 and earn a "B" or better.

Acceptable Substitutions

All allowed substitutions were encoded in the footnotes of the Program Requirements.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

Chemistry Major (B.S.)

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1004	First Year Experience in Chemistry	1
CHEM 1055	General Chemistry for Chemistry Majors [1,2]	4
CHEM 1056	General Chemistry for Chemistry Majors [1,2]	4
CHEM 1065	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 1066	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 2565	Principles of Organic Chemistry [1,4]	3
CHEM 2566	Principles of Organic Chemistry [1,4]	3
CHEM 2154	Analytical Chemistry for Chemistry Majors [1]	4
CHEM 2164	Analytical Chemistry for Chemistry Majors Lab [1]	1
Subtotal		22
Additional Course Requirements		
CHEM 2555	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2556	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2564	Problem-Solving in Organic Chemistry	1
CHEM 3004	Bridge to the Future	1
CHEM 4014	Survey of Chemical Literature [1]	1
Subtotal		7
Major Requirements		
CHEM 2424	Descriptive Inorganic Chemistry [1]	3
CHEM 3615	Physical Chemistry [1,6]	3

CHEM 3616	Physical Chemistry [1]	3
CHEM 3625	Physical Chemistry Laboratory [1]	1
CHEM 3626	Physical Chemistry Laboratory [1]	1
CHEM 4114	Instrumental Analysis [1]	3
CHEM 4124	Instrumental Analysis Laboratory [1]	1
CHEM 4404	Physical Inorganic Chemistry [1]	3
CHEM 4414	Inorganic Chemistry Lab [1]	2
Select one of the following:		3
CHEM 4534	Organic Chemistry of Polymers [1]	
CHEM 4634	Polymer and Surface Chemistry [1]	
CHEM/SBIO 4424	Polysaccharide Chemistry [1]	
CHEM 4584	Bioorganic Chemistry [1]	3
MATH 2114	Introduction to Linear Algebra	3
MATH 2204	Introduction to Multivariable Calculus [1]	3
MATH 2214	Introduction to Differential Equations [1]	3
Subtotal		35
Restricted Electives		
Students may choose any 3-credit, 4000-level course in CHEM, BCHM, or CHE for which applicable prerequisites are met. [7]		3
Subtotal		3
Free Electives		
Select remaining credit hours of free elective to fulfill 120 credit hour requirement		4
Subtotal		4
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) (foundational writing or speaking courses) and three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (advanced or applied writing or speaking courses).		9
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits of Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits of Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [8]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (5F) [1]	8
STAT 3005 or STAT 3615	Statistical Methods (5A) [1,9] Biological Statistics	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits of Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1 Course has prerequisites. Consult the catalog.

2 *General Chemistry Lecture Substitutions*. A student who earned credit for CHEM 1035 with a grade of"B" or better prior to joining the major in Chemistry may substitute CHEM 1035 for CHEM 1055. A student who earned credit for CHEM 1036 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1036 for CHEM 1056.

3 *General Chemistry Lab Substitutions*. A student who earned credit for CHEM 1045 prior to joining the major in Chemistry may substitute CHEM 1045 for CHEM 1065. A student who earned credit for CHEM 1046 prior to joining the major in Chemistry may substitute CHEM 1046 for CHEM 1066.

4 *Organic Chemistry Lecture Substitutions*. A student who earned credit for CHEM 2535 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2535 for CHEM 2565. A student who is substituting CHEM 2535 for CHEM 2565 may also substitute one additional credit of free elective for the one credit CHEM 2564, since CHEM 2564 is meant as a companion course to CHEM 2565. A student who earned credit for CHEM 2536 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2536 for CHEM CHEM 2566.

5 *Organic Chemistry Lab Substitutions.* A student who earned credit for CHEM 2545 prior to joining the major in Chemistry may substitute CHEM 2545 for CHEM 2555. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR). A student who earned credit for CHEM 2546 prior to joining the major in Chemistry may substitute CHEM CHEM 2546 for CHEM 2556. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR).

6 Credit for CHE 2164 Chemical Engineering Thermodynamics may be substituted for CHEM 3615.

7 Three credits of CHEM 4994 Undergraduate Research may substitute for the Restricted Elective.

8 PSYC 1004 and SOC 1004 are recommended for students pursuing health-science professions.

9 STAT 4604 may be substituted for (STAT 3005 or STAT 3615).

1 A course with prerequisites or co-requisites.

2 Prior credit for CHEM 1045 General Chemistry Laboratory may be substituted for CHEM 1065 General Chemistry for Chemistry Majors Lab.

3 Prior credit for CHEM 1046 General Chemistry Laboratory may be substituted for CHEM 1066 General Chemistry for Chemistry Majors Lab.

4 If a student has taken CHEM 2535 Organic Chemistry prior to adding a degree in chemistry, a minimum grade of "B" (3.0) or better is required to substitute CHEM 2535 Organic Chemistry as CHEM 2565 Principles of Organic Chemistry. If a student has taken CHEM 2536 Organic Chemistry prior to adding a degree in chemistry, a minimum grade of "B" (3.0) or better is required to substitute CHEM 2536 Organic Chemistry as CHEM 2566 Principles of Organic Chemistry.

5 Since CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory does not satisfy the prerequisite for CHEM 2556 Organic Synthesis and Techniques Lab (due to training on specific instrumentation), if a student adds a CHEM BS degree after completing CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory, two or more credits of CHEM 4994 Undergraduate Research may substitute for CHEM 2556 Organic Synthesis and Techniques Lab to meet the requirement.

6 MATH 1225 Calculus of a Single Variable–MATH 1226 Calculus of a Single Variable[1] and PHYS 2305 Foundations of Physics–PHYS 2306 Foundations of Physics[1] are also required of all Chemistry Majors within the B.S. Degree Program in Chemistry. These courses are listed in the Pathways to General Education section.

7 STAT 4604 Statistical Methods for Engineers may be substituted for (STAT 3005 Statistical Methods or STAT 3615 Biological Statistics).

8 Credit for CHEM 2164 Analytical Chemistry for Chemistry Majors Lab may be substituted for CHEM 3615 Physical Chemistry

9 PSYC 1004 Introductory Psychology and SOC 1004 Introductory Sociology are recommended for students contemplating careers in health sciences.

10 Students majoring in Chemistry within the B.S. Degree in Chemistry must select either STAT 3005 Statistical Methods[1] or STAT 3615 Biological Statistics[1].

Prerequisites

This checksheet has no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Please see your advisor or consult the Undergraduate Course Catalog for more information. Please note that Chemistry majors are expected to be “calculus-ready” upon the start of their curriculum.

Graduation Requirements

Upon having attempted 72 credits, student must have completed

Code	Title	Credits
CHEM 1055	General Chemistry for Chemistry Majors	4
CHEM 1056	General Chemistry for Chemistry Majors	4
CHEM 1065	General Chemistry for Chemistry Majors Lab	1
CHEM 1066	General Chemistry for Chemistry Majors Lab	1
CHEM 1004	First Year Experience in Chemistry	1
CHEM 2565	Principles of Organic Chemistry	3
CHEM 2566	Principles of Organic Chemistry	3
CHEM 2555	Organic Synthesis and Techniques Lab	2
CHEM 2556	Organic Synthesis and Techniques Lab	2
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
MATH 1225	Calculus of a Single Variable	4
MATH 1226	Calculus of a Single Variable	4

Chemistry majors must maintain an in-major GPA of 2.0. If a chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Graduation Requirements

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes CHEM 1015, CHEM 1016, CHEM 1025, CHEM 1026, CHEM 1014, and CHEM 1004). No more than 6 hours of CHEM 2974, CHEM 4974, and CHEM 4994 will be included in a student's in-major GPA.

Minimum Grade Requirements

- A Chemistry major who earned a grade lower than "C" in CHEM 1055 must either repeat this course and earn the minimum grade ("C" or better) **or** take CHEM 1035 and earn a “B” or better.
- A Chemistry major who earned a grade lower than "C" in CHEM 1056 must either repeat this course and earn the minimum grade ("C" or better) **or** take CHEM 1036 and earn a “B” or better.
- A Chemistry major who earned a grade lower than "C" in CHEM 2565 must either repeat this course and earn the minimum grade ("C" or better) **or** take CHEM 2535 and earn a “B” or better.

Acceptable Substitutions

All substitutions have been encoded as footnotes in the Program Requirements section.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

Medicinal Chemistry Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1004	First Year Experience in Chemistry	1
CHEM 1055	General Chemistry for Chemistry Majors [1]	4
CHEM 1056	General Chemistry for Chemistry Majors [1]	4
CHEM 1065	General Chemistry for Chemistry Majors Lab [1,2]	1
CHEM 1066	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 2565	Principles of Organic Chemistry [1,4]	3
CHEM 2566	Principles of Organic Chemistry [1,4]	3
CHEM 2154	Analytical Chemistry for Chemistry Majors [1]	4
CHEM 2164	Analytical Chemistry for Chemistry Majors Lab [1]	1
Subtotal		22
Additional Required Courses		
CHEM 2555	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2556	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2564	Problem-Solving in Organic Chemistry [1,4]	1
CHEM 3004	Bridge to the Future	1

CHEM 4014	Survey of Chemical Literature [1]	1
Subtotal		7
Major Requirements		
BIOL 1105	Principles of Biology	3
BIOL 1106	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 4615	Physical Chemistry for the Life Sciences [1,6]	3
CHEM 4616	Physical Chemistry for the Life Sciences [1,6]	3
CHEM 4544	Medicinal Chemistry Capstone Laboratory [1]	2
CHEM 4584	Bioorganic Chemistry [1]	3
Subtotal		19
Restricted Electives [7]		
Select two of the following:		6
CHEM 4524	Identification of Organic Compounds [1]	
CHEM 4514	Green Chemistry [1]	
CHEM 4554	Drug Chemistry [1]	
CHEM 4444	Bioinorganic Chemistry [1]	
CHEM/SBIO 4424	Polysaccharide Chemistry [1]	
Subtotal		6
Free Electives		
Select 17 credits of free electives		17
Subtotal		17
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) (foundational writing or speaking courses) and three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (advanced speaking and writing courses)		9
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [8]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory [1,9]	4
PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory [1,9]	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [1]	4
MATH 1226	Calculus of a Single Variable (5F) [1]	4
STAT 3615 or STAT 3005	Biological Statistics Statistical Methods	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 3 credits in design or 3 credits in arts or 6 credits in integrated design and arts.		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. Course has prerequisites. Consult the catalog for details.
2. *General Chemistry Lecture Substitutions*. A student who earned credit for CHEM 1035 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1035 for CHEM 1055. A student who earned credit for CHEM 1036 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1036 for CHEM 1056.
3. *General Chemistry Lab Substitutions*. A student who earned credit for CHEM 1045 prior to joining the major in Chemistry may substitute CHEM 1045 for CHEM 1065. A student who earned credit for CHEM 1046 prior to joining the major in Chemistry may substitute CHEM 1046 for CHEM 1066.
4. *Organic Chemistry Lecture Substitutions*. A student who earned credit for CHEM 2535 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2535 for CHEM 2565. A student who is substituting CHEM 2535 for CHEM 2565 may also substitute one additional credit of free elective for the one credit CHEM 2564, since CHEM 2564 is meant as a companion course to CHEM 2565. A student who earned credit for CHEM 2536 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2536 for CHEM 2566.
5. *Organic Chemistry Lab Substitutions.* A student who earned credit for CHEM 2545 prior to joining the major in Chemistry may substitute CHEM 2545 for CHEM 2555. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR). A student who earned credit for CHEM 2546 prior to joining the major in Chemistry may substitute CHEM 2546 for CHEM 2556. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR).
6. *Physical Chemistry Substitutions.* CHEM 3615 may be substituted for CHEM 4615. CHEM 3616 may be substituted for CHEM 4616.
7. Unlike the Major in Chemistry, credits for CHEM 4994 Undergraduate Research may NOT be counted toward the nine credits of Restricted Electives.
8. PSYC 1004 and SOC 1004 are recommended for students pursuing health-science professions.
9. *Physics Substitutions*. PHYS 2305 may be substituted for PHYS 2205 and PHYS 2215; PHYS 2306 may be substituted for PHYS 2206 and PHYS 2216

Satisfactory Progress Towards Degree

Upon having attempted 72 credits, student must have completed

Code	Title	Credits
CHEM 1055	General Chemistry for Chemistry Majors	4
CHEM 1056	General Chemistry for Chemistry Majors	4
CHEM 1065	General Chemistry for Chemistry Majors Lab	1
CHEM 1066	General Chemistry for Chemistry Majors Lab	1
CHEM 1004	First Year Experience in Chemistry	1
CHEM 2565	Principles of Organic Chemistry	3

CHEM 2566	Principles of Organic Chemistry	3
CHEM 2555	Organic Synthesis and Techniques Lab	2
CHEM 2556	Organic Synthesis and Techniques Lab	2
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory	4
PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory	4
MATH 1225	Calculus of a Single Variable	4
MATH 1226	Calculus of a Single Variable	4

Medicinal chemistry majors must maintain an in-major GPA of 2.0. If a medicinal chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Graduation Requirements

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes CHEM 1015, CHEM 1016, CHEM 1025, CHEM 1026, CHEM 1004, and CHEM 1014. No more than 6 hours of CHEM 2974, CHEM 4974, and CHEM 4994 will be included in a student's in-major GPA.

Minimum Grade Requirements

A Medicinal Chemistry major who earned a grade lower than "C" in CHEM 1055 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1035 and earn a "B" or better.

A Medicinal Chemistry major who earned a grade lower than "C" in CHEM 1056 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1036 and earn a "B" or better.

A Medicinal Chemistry major who earned a grade lower than "C" in CHEM 2565 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 2535 and earn a "B" or better.

Acceptable Substitutions

Substitutions have been encoded into the Program Requirements as footnotes.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

Polymer Chemistry Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1004	First Year Experience in Chemistry	1
CHEM 1055	General Chemistry for Chemistry Majors [1,2]	4
CHEM 1056	General Chemistry for Chemistry Majors [1,3]	4
CHEM 1065	General Chemistry for Chemistry Majors Lab [1,3]	1
CHEM 1066	General Chemistry for Chemistry Majors Lab [1,2,3]	1
CHEM 2565	Principles of Organic Chemistry [1,4]	3
CHEM 2566	Principles of Organic Chemistry [1,4]	3
CHEM 2154	Analytical Chemistry for Chemistry Majors [1]	4
CHEM 2164	Analytical Chemistry for Chemistry Majors Lab [1]	1
Subtotal		22
Additional Course Requirements		
CHEM 2555	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2556	Organic Synthesis and Techniques Lab [1,5]	2
CHEM 2564	Problem-Solving in Organic Chemistry	1
CHEM 3004	Bridge to the Future	1
CHEM 4014	Survey of Chemical Literature [1]	1
Subtotal		7
Major Requirements		
MATH 2204	Introduction to Multivariable Calculus [1]	3
CHEM 3615	Physical Chemistry [1,6]	3
CHEM 3625	Physical Chemistry Laboratory [1]	1
CHEM 4534	Organic Chemistry of Polymers [1]	3
CHEM 4074/ MSE 4544	Laboratory in Polymer Science [1]	2
Subtotal		12
Restricted Electives [7]		
Select three of the following:		9
CHEM 4424	Polysaccharide Chemistry [1]	
CHEM 4524	Identification of Organic Compounds [1]	
CHEM 4624	Materials Chemistry in Energy Sciences	
CHEM 4634	Polymer and Surface Chemistry [1]	
CHE 4104	Process Materials [1]	
CHE 4214	Introduction to Polymer Materials	
CHE 4224	Introduction to Polymer Processing	
PHYS 4564	Polymer Physics [1]	
Subtotal		9
Free Electives		
Select 21 credits of free electives		21
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F) (foundational writing or speaking courses) and three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A) (advanced or applied writing or speaking courses)		9
Pathways Concept 2 - Critical Thinking in the Humanities		

Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics [1]	4
PHYS 2306	Foundations of Physics [1]	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (5F) [1]	8
STAT 3005 or STAT 3615	Statistical Methods (5A) [1,8] Biological Statistics	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
6 credits = 3 in design + 3 in arts, or 6 in integrated design and arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. Course has prerequisites. Please consult the course catalog for details.
2. *General Chemistry Lecture Substitutions*. A student who earned credit for CHEM 1035 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1035 for CHEM 1055. A student who earned credit for CHEM 1036 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 1036 for CHEM 1056.
3. *General Chemistry Lab Substitutions*. A student who earned credit for CHEM 1045 prior to joining the major in Chemistry may substitute CHEM 1045 for CHEM 1065. A student who earned credit for CHEM 1046 prior to joining the major in Chemistry may substitute CHEM 1046 for CHEM 1066.
4. *Organic Chemistry Lecture Substitutions*. A student who earned credit for CHEM 2535 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2535 for CHEM 2565. A student who is substituting CHEM 2535 for CHEM 2565 may also substitute one additional credit of free elective for the one credit CHEM 2564, since CHEM 2564 is meant as a companion course to CHEM 2565. A student who earned credit for CHEM 2536 with a grade of "B" or better prior to joining the major in Chemistry may substitute CHEM 2536 for CHEM 2566.
5. *Organic Chemistry Lab Substitutions.* A student who earned credit for CHEM 2545 prior to joining the major in Chemistry may substitute CHEM 2545 for CHEM 2555. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR). A student who earned credit for CHEM 2546 prior to joining the major in Chemistry may substitute CHEM 2546 for CHEM 2556. To compensate for differences in content (mostly with respect to training on specific instrumentation), the substitution requires the student to enroll in one credit of CHEM 4994 with a project that uses the same types of instrumentation (such as IR and NMR).
6. Credit for CHE 2164 Chemical Engineering Thermodynamics may be substituted for CHEM 3615.
7. Unlike the Major in Chemistry, credits for CHEM 4994 may NOT be counted toward the nine credits of Restricted Electives.
8. STAT 4604 may be substituted for (STAT 3005 or STAT 3615).

Upon having attempted 72 credits, student must have completed

Code	Title	Credits
CHEM 1055	General Chemistry for Chemistry Majors	4
CHEM 1056	General Chemistry for Chemistry Majors	4
CHEM 1065	General Chemistry for Chemistry Majors Lab	1
CHEM 1066	General Chemistry for Chemistry Majors Lab	1
CHEM 1004	First Year Experience in Chemistry	1
CHEM 2565	Principles of Organic Chemistry	3
CHEM 2566	Principles of Organic Chemistry	3
CHEM 2555	Organic Synthesis and Techniques Lab	2
CHEM 2556	Organic Synthesis and Techniques Lab	2
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
MATH 1225	Calculus of a Single Variable	4
MATH 1226	Calculus of a Single Variable	4

Polymer chemistry majors must maintain an in-major GPA of 2.0. If a polymer chemistry major fails to meet this requirement for one academic term the student will be placed on Policy 91 (Satisfactory Progress Towards Degree) probation. Failure to meet the standard for two consecutive semesters will result in a Policy 91 suspension.

Graduation Requirements

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.0 or greater counting all required chemistry courses and chemistry electives. The in-major CHEM GPA excludes CHEM 1015, CHEM 1016, CHEM 1025, CHEM 1026, CHEM 1004, and CHEM 1014 . No more than 6 hours of CHEM 2974, CHEM 4974, and CHEM 4994 will be included in a student's in-major GPA.

Minimum Grade Requirements

- A Polymer Chemistry major who earned a grade lower than "C" in CHEM 1055 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1035 and earn a "B" or better.
- A Polymer Chemistry major who earned a grade lower than "C" in CHEM 1056 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 1036 and earn a "B" or better.
- A Polymer Chemistry major who earned a grade lower than "C" in CHEM 2565 may repeat this course and earn the required grade ("C" or better), or they may take CHEM 2535 and earn a "B" or better.

Acceptable Substitutions

Substitutions have been encoded into the Program Requirements as footnotes.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduates. Please consult the Undergraduate Catalog for details.

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Computational Modeling and Data Analytics

Our Website (https://data.science.vt.edu/programs/cmda.html)

Overview

The Computational Modeling and Data Analytics (CMDA) program is a collaborative effort of the departments of Mathematics, Statistics, and Computer Science. It resides in the College of Science's Academy of Data Science. CMDA courses teach the range of emerging concepts and techniques from mathematics and statistics, with a decidedly computational approach, that are most in demand by a data-driven world. The curriculum prepares students as quantitative scientists ready to engage data and modeling problems wherever they may occur. CMDA is Virginia Tech's Big Data degree.

In addition to the standard degree option, CMDA offers specialized options in: Biological Sciences, Cryptography & Cybersecurity, Economics, Geosciences, and Physics. After graduation, CMDA majors can deploy their skills across many domains, from climate science to sports analytics, from financial modeling to cybersecurity. Diverse job opportunities abound.

During senior year, CMDA majors undertake a major Capstone Project (CMDA 4864), collaborating with a team of students to tackle an open-ended modeling or analytics challenge from a client in industry, government, academia, or the non-profit sector.

Each Spring the CMDA program awards approximately $50,000 in Hamlett Scholarships, primarily to continuing students. Majors are also eligible to apply for CMDA Undergraduate Research Grants, awarded for Fall, Spring, and Summer research.

Bachelor of Science in Computational Modeling and Data Analytics

Please direct advising inquires to cmda-advising@vt.edu.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "Academic Policies (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Computational Modeling and Data Analytics can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Computer Literacy

Most CMDA courses involve the use of statistical and/or mathematical software, typically including (but not limited to) Python, R, C, Java, and MATLAB. Previous experience with these languages is not expected; students will learn the necessary tools throughout the CMDA curriculum.

- Computational Modeling and Data Analytics Major (p. 1258)
- Computational Modeling and Data Analytics Major with Biological Sciences Option (p. 1259)
- Computational Modeling and Data Analytics Major with Cryptography and Cybersecurity Option (p. 1261)
- Computational Modeling and Data Analytics Major with Economics Option (p. 1262)
- Computational Modeling and Data Analytics Major with Geosciences Option (p. 1263)
- Computational Modeling and Data Analytics Major with Physics Option (p. 1265)

Division Leader: M. Embree
Program Manager: H. Caldwell
Undergraduate Advisor: J.S. Whitehead
Principle Faculty: N. Abaid, C. Beattie, P. Cazeaux, L. Childs, J. Datta, E. de Sturler, X. Deng, F. Faltin, R. Gramacy, S. Gugercin, A. Habibnia, P. Haskell, D. Higdon, L. House, L. Johnson, I. Kim, S. Leman, C. Lucero, D. Lucero, M. Liu, G. Matthews, S. Merkes, A. Miedlar, J. P. Morgan, C. North, A. Patterson, L. Pillonen, M. Pleimling, N. Ramakrishnan, C. Ribbens, J. Rudi, E. Smith, E. Ufferman, T. Warburton, J. Wilson, X. Xing, and L. Zeitsman

Undergraduate Course Descriptions (CMDA)

CMDA 1634 - Discovering Computational Modeling and Data Analytics (3 credits)
An introduction to the practice and profession of Computational Modeling and Data Analytics. Acquaints students with foundational computational tools, solving problems with modeling and data, visualization, ethical considerations in data science, professional opportunities in the field, and advising resources at Virginia Tech.
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2005 - Integrated Quantitative Sciences (6 credits)
2005: Integrated topics from quantitative sciences that prepare students for advanced computational modeling and data analytics courses. Topics include: probability and statistics, infinite series, multivariate calculus, linear algebra. 2006: Intermediate linear algebra, regression, differential equations, and model validation.
Prerequisite(s): MATH 1226
Corequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (6 Lec, 6 Crd)

CMDA 2006 - Integrated Quantitative Sciences (6 credits)
2005: Integrated topics from quantitative sciences that prepare students for advanced computational modeling and data analytics courses. Topics include: probability and statistics, infinite series, multivariate calculus, linear algebra. 2006: Intermediate linear algebra, regression, differential equations, and model validation.
Prerequisite(s): CMDA 2005 and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (6 Lec, 6 Crd)

CMDA 2014 - Data Matter (3 credits)
This course develops fundamental analytical and programming skills to complete the “analytic pipeline”, including specifying research questions, selecting/collecting data ethically and responsibly, processing and summarizing datasets, and stating findings, while considering all assumptions made. Students will identify vulnerabilities in analyses, including sources of bias and ethical implications. Some programming skills recommended, but not required. Some prior use of data recommended, but not required.
Prerequisite(s): MATH 1014
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 2984E - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

CMDA 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 3274 - Introduction Sports Analytics (3 credits)
Introduction to sports analytics, sources of sports analytics data and data collection methods, visualization techniques, game performance statistics, inferential statistics and predictive modeling techniques for sports data. Role and applications of data analytics in the sports industry.
Prerequisite(s): CMDA 2006 or STAT 3006
Corequisite(s): CMDA 3654 or CS 3654 or STAT 3654.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 3274

CMDA 3605 - Mathematical Modeling: Methods and Tools (3 credits)
3605: Mathematical modeling with ordinary differential equations and difference equations. Numerical solution and analysis of ordinary differential equations and difference equations. Stochastic modeling, and numerical solution of stochastic differential equations. 3606: Concepts and techniques from numerical linear algebra, including iterative methods for solving linear systems and least squares problems, and numerical approaches for solving eigenvalue problems. Ill-posed inverse problems such as parameter estimation, and numerical methods for computing solutions to inverse problems. Numerical optimization. Emphasis on large-scale problems.
Prerequisite(s): (CS 1114 or CS 1064 or MATH 1454) and (MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 3606 - Mathematical Modeling: Methods and Tools (3 credits)
3605: Mathematical modeling with ordinary differential equations and difference equations. Numerical solution and analysis of ordinary differential equations and differencee equations. Stochastic modeling and numerical solution of stochastic differential equations. 3606: Concepts and techniques from numerical linear algebra, including iterative methods for solving linear systems and least squares problems, and numerical approaches for solving eigenvalue problems. III-posed inverse problems such as parameter estimation, and numerical methods for computing solutions to inverse problems. Numerical optimization. Emphasis on large-scale problems.
Prerequisite(s): CMDA 3605
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 3634 - Computer Science Foundations for Computational Modeling & Data Analytics (3 credits)
Survey of computer science concepts and tools that enable computational science and data analytics. Data structure design and implementation. Analysis of data structure and algorithm performance. Introduction to high-performance computer architectures and parallel computation. Basic operating systems concepts that influence the performance of large-scale computational modeling and data analytics. Software development and software tools for computational modeling. Not for CS major credit.
Prerequisite(s): CS 2114
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3634

CMDA 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3654, STAT 3654

CMDA 4274 - Sports Analytics Statistical Research (3 credits)
Statistical analysis of sports data. Game performance statistics and expected scores. Analysis of player performance, player tracking, team performance, and sports betting. Bayesian methods and prediction models applied to sports data. Decision-making. Assessing sports analytics research and literature.
Prerequisite(s): (STAT 4214 and STAT 4444) or (CMDA 4654 or CS 4654 or STAT 4654) or (STAT 3274 or CMDA 3274)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4274

CMDA 4314 - Big Data Economics (3 credits)
Applied econometrics dealing with big data. Theoretical, computational, and statistical underpinnings of big data analysis. The use of econometric models and deep machine learning algorithms to analyze the high-dimensional data sets. Implications in research focusing on economic questions that arise from rapid changes in data availability and computational technology. Materials are hands-on tutorials that come with Python codes and real-world data sets.
Prerequisite(s): ECON 3254 or ECON 4304 or CMDA 3654 or STAT 3006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4314

CMDA 4604 - Intermediate Topics in Mathematical Modeling (3 credits)
Introduction to partial differential equations, including modeling and classification of partial differential equations. Finite difference and finite elements methods for the numerical solution of partial differential equations including function approximation, interpolation, and quadrature. Numerical solution of nonlinear systems of equations. Uncertainty quantification, prediction.
Prerequisite(s): CMDA 3606
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4634 - Scalable Computing for Computational Modeling and Data Analytics (3 credits)
A focused study of concepts and tools that accelerate computational and data science at scale. Design, analysis, optimization, and modeling of application-driven algorithms suitable for state-of-the-art scalable computing platforms. Software development and engineering for scalable computational science.
Prerequisite(s): (CMDA 3634 or CS 3634 or CS 4234) and (CMDA 3654 or CS 3654 or STAT 3654) and (CMDA 3605 or CS 3414 or MATH 3414 or MATH 4445)
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706) and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 4654, STAT 4654

CMDA 4664 - Computational Intensive Stochastic Modeling (3 credits)
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models.
Prerequisite(s): (STAT 4106 or CMDA 3605) and (CS 1114 or CS 1064 or STAT 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: STAT 4664

CMDA 4864 - Computational Modeling and Data Analytics Capstone Project (3 credits)
Capstone research project for Computational Modeling and Data Analytics majors. Cultivates skills including reviewing the literature, creative problem solving, teamwork, critical thinking, and oral, written, and visual communications. Quantitative and computational thinking, informed throughout by ethical reasoning.
Prerequisite(s): CMDA 3605 and CMDA 3634 or CS 3634 and CMDA 3654 or CS 3654 or STAT 3654
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

CMDA 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

CMDA 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Computational Modeling and Data Analytics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3
CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3
CMDA 2005	Integrated Quantitative Sciences *†	6
CMDA 2006	Integrated Quantitative Sciences *†	6
CS 1064	Introduction to Programming in Python *‡	3
CS 2064	Intermediate Programming in Python *‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Restricted Electives		
Select four of the following:		12
CMDA/ECON 4314	Big Data Economics *	
CMDA 4604	Intermediate Topics in Mathematical Modeling *	
CMDA 4634	Scalable Computing for Computational Modeling and Data Analytics *	
CMDA/STAT 4664	Computational Intensive Stochastic Modeling *	
CS 3114	Data Structures and Algorithms *	
CS 4104	Data and Algorithm Analysis *	
CS 4134	Quantum Computation and Information Processing *	
CS 4604	Introduction to Data Base Management Systems *	
CS 4824/ ECE 4424	Machine Learning *	
FREC 3044	Environmental Data Science *	
GEOG/GEOS 4084	Modeling with Geographic Information Systems *	
MATH 3134	Applied Combinatorics and Graph Theory *	
MATH 4144	Linear Algebra II *	
MATH 4175	Cryptography *	
MATH 4176	Cryptography *	
MATH 4425	Fourier Series and Partial Differential Equations *	
MATH 4426	Fourier Series and Partial Differential Equations *	
MATH 4445	Introduction to Numerical Analysis *	

MATH 4446	Introduction to Numerical Analysis *	
STAT/CMDA 3274	Introduction to Sports Analytics Research *	
STAT 4004	Methods of Statistical Computing *	
STAT 4204	Experimental Designs *	
STAT 4214	Methods of Regression Analysis *	
STAT/CMDA 4274	Sports Analytics Statistical Research *	
STAT 4364	Introduction to Statistical Genomics *	
STAT 4444	Applied Bayesian Statistics *	
STAT 4504	Applied Multivariate Analysis *	
STAT 4514	Introduction to Categorical Data Analysis *	
STAT 4534	Applied Statistical Time Series Analysis *	
STAT 4744	Deep Learning *	
PHYS 4755	Introduction to Computational Physics *	
Subtotal		12
Free Electives		
Select remaining credits of free electives		19
Subtotal		19
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) ^		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

* Courses will be used for computing the “in major” GPA.

† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.

‡ CS 1114 will substitute for (CS 1064 and CS 2064).

\# Any approved First Year Experience (FYE) Course at Virginia Tech will satisfy this requirement.

^ To fulfill the Pathways Concept 4: Reasoning in the Natural Sciences requirements, only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C—** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).

2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.

3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Computational Modeling and Data Analytics Major with Biological Sciences Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3

CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3
CMDA 2005	Integrated Quantitative Sciences *†	6
CMDA 2006	Integrated Quantitative Sciences *†	6
CS 1064	Introduction to Programming in Python *‡	3
CS 2064	Intermediate Programming in Python *‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Option Required Courses		
BIOL 1105	Principles of Biology	3
BIOL 1115	Principles of Biology Laboratory	1
BIOL 1106	Principles of Biology	3
BIOL 1116	Principles of Biology Laboratory	1
Select two of the following:		6
BIOL 2004	Genetics *	
BIOL 2134	Cell Function and Differentiation *	
BIOL 2604	General Microbiology *	
BIOL 2704	Evolutionary Biology *	
BIOL 2804	Ecology *	
Subtotal		14
BIOL/SYSB Elective Courses		
Select two of the following:		6-8
BIOL 4004	Freshwater Ecology *	
BIOL 4114	Global Change Ecology *	
BIOL 4134	Evolutionary Genetics *	
BIOL 4564	Infectious Disease Ecology *	
BIOL 4624	Microbial Genetics *	
BIOL 4664	Virology *	
BIOL 4874	Cancer Biology *	
SYSB 3035	Genomics and Bioinformatics *	
SYSB 3036	Genomics and Bioinformatics *	
SYSB 3115	Network Dynamics and Cell Physiology *	
SYSB 3116	Network Dynamics and Cell Physiology *	
Subtotal		6-8
CMDA Elective Courses		
Select one of the following:		3
CMDA/STAT 4664	Computational Intensive Stochastic Modeling *	
CS 3824	Introduction to Computational Biology and Bioinformatics *	
FREC 3044	Environmental Data Science *	
MATH 4454	Applied Mathematical Modeling *	
STAT 4364	Introduction to Statistical Genomics *	
Subtotal		3
Free Electives		
Select remaining credits of free electives (Students may need to complete less credit hours in this category depending on choices in categories above)		8
Subtotal		8
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
CHEM 1035	General Chemistry	3
CHEM 1036	General Chemistry	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120-122**

* Courses will be used for computing the "in major" GPA.

† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.

‡ CS 1114 will substitute for (CS 1064 and CS 2064).

\# Any approved First Year Experience (FYE) course at Virginia Tech will satisfy this requirement.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C—** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).
2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or

better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.

3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Course Catalog (https://catalog.vt.edu) for details.

Computational Modeling and Data Analytics Major with Cryptography and Cybersecurity Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3
CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3
CMDA 2005	Integrated Quantitative Sciences *†	6
CMDA 2006	Integrated Quantitative Sciences *†	6
CS 1064	Introduction to Programming in Python *‡	3
CS 2064	Intermediate Programming in Python *‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Option Required Courses		
BIT/CS/PSCI 2164	Foundations of Contemporary Security Environments *	3
BIT/CS/PSCI 4164	Future of Security: Integrative Solutions for Complex Security Systems *	3
CS 2505	Introduction to Computer Organization *	3
MATH 2534	Introduction to Discrete Mathematics *	3
MATH 4175	Cryptography *	3
MATH 4176	Cryptography *	3
Subtotal		18
Additional Course Requirements		
Select one of the following:		3
CS 3714	Mobile Software Development *	
CS 3754	Cloud Software Development *	
Subtotal		3
Restricted Electives		
Select two of the following:		6
BIT 4624	Cybersecurity Analytics for Business *	
CMDA 4634	Scalable Computing for Computational Modeling and Data Analytics *	
CS 4134	Quantum Computation and Information Processing *	
CS 4264	Principles of Computer Security *	
FIN 4014	Cyberlaw and Policy *	
MATH 3124	Modern Algebra *	
MATH 3134	Applied Combinatorics and Graph Theory *	
PHYS 4254	Quantum Information Technologies *	
Subtotal		6
Free Electives		
Select remaining credits of free electives		4
Subtotal		4
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) ^		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3

Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	47
Total Credits	**120**

* Courses will be used for computing the "in major" GPA.
† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.
‡ CS 1114 will substitute for (CS 1064 and CS 2064).
# Any approved First Year Experience (FYE) course at Virginia Tech will satisfy this requirement.
^ To fulfill the Pathways Concept 4: Reasoning in the Natural Sciences requirements, only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C–** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).
2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.
3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses may have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog (https://catalog.vt.edu) for details.

Computational Modeling and Data Analytics Major with Economics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3
CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3
CMDA 2005	Integrated Quantitative Sciences *†	6
CMDA 2006	Integrated Quantitative Sciences *†	6
CS 1064	Introduction to Programming in Python *‡	3
CS 2064	Intermediate Programming in Python *‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Option Required Courses		
ECON 3104	Microeconomic Theory *	3
ECON 3204	Macroeconomic Theory *	3
ECON 4304	Introduction to Econometric Methods *	3
CMDA/ECON 4314	Big Data Economics *	3
Subtotal		12
Elective Courses		
Select one of the following:		3
ECON 3054	Introduction to Forecasting *	
ECON 4044	Public Economics *	
ECON 4054	Public Finance *	
ECON 4074	Labor Economics *	
ECON 4084	Industry Structure *	
ECON 4124	Growth and Development *	
ECON/AAEC 4135	International Economics *	
ECON/AAEC 4136	International Economics *	
ECON 4404	Economics of Organizations *	
ECON 4424	The Theory of Games and Economic Behavior *	
ECON 4434	Experimental Economics *	
NEUR/ECON/PSYC 4454	Neuroeconomics *	
Subtotal		3
Restricted Electives		

Select one of the following:		3
CMDA 4604	Intermediate Topics in Mathematical Modeling *	
CMDA/STAT 4664	Computational Intensive Stochastic Modeling *	
MATH 4445	Introduction to Numerical Analysis *	
STAT 4204	Experimental Designs *	
STAT 4444	Applied Bayesian Statistics *	
Subtotal		3
Free Electives		
Select remaining credits of free electives		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
ECON 2005	Principles of Economics	3
ECON 2006	Principles of Economics	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) ^		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		60
Total Credits		**120**

* Courses will be used for computing the "in major" GPA.

† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.

‡ CS 1114 will substitute for (CS 1064 and CS 2064).

\# Any approved First Year Experience (FYE) course at Virginia Tech will satisfy this requirement.

^ To fulfill Pathways Concept 4: Reasoning in the Natural Sciences requirements, only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C—** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).
2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.
3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses in the major requirements and electives above have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog (https://catalog.vt.edu) for details.

Computational Modeling and Data Analytics Major with Geosciences Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3
CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3

CMDA 2005	Integrated Quantitative Sciences * †	6
CMDA 2006	Integrated Quantitative Sciences * †	6
CS 1064	Introduction to Programming in Python * ‡	3
CS 2064	Intermediate Programming in Python * ‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Option Required Courses		
GEOS 1104	Introduction to Earth Sciences Laboratory *	1
GEOS 3024	Computational Methods in the Geosciences *	3
Select one of the following:		3
GEOS 3204	Sedimentology-Stratigraphy *	
GEOS 3404	Elements of Structural Geology *	
Subtotal		7
Restricted Electives		
Select three of the following, including at least one experiential learning course marked with "E".		9-12
FREC 3044	Environmental Data Science *	
GEOG 4254	R Programming for Geospatial Applications *	
GEOS 3034	Oceanography *	
GEOS 3104	Elementary Geophysics (E) *	
GEOS 3204	Sedimentology-Stratigraphy (E) *	
GEOS 3404	Elements of Structural Geology (E) *	
GEOS/GEOG 4084	Modeling with Geographic Information Systems *	
GEOS 4124	Seismic Stratigraphy *	
GEOS 4164	Potential Field Methods in Exploration Geophysics (E) *	
GEOS 4174	Exploration Seismology *	
GEOS/GEOG 4354	Introduction to Remote Sensing (E) *	
GEOS 4804	Groundwater Hydrology (E) *	
GEOS 4924	Tectonics (E) *	
Subtotal		9-12
Free Electives		
Select remaining credits of free electives (Students may need to complete less credit hours in this category depending on choices in categories above)		15
Subtotal		15
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
GEOS 1004	Earth Science: Our Past, Present, and Future	3
GEOS 1014	Evolution of the Earth-Life System	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120-123**

* Courses will be used for computing the "in major" GPA.

† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.

‡ CS 1114 will substitute for (CS 1064 and CS 2064).

\# Any approved First Year Experience (FYE) course at Virginia Tech will satisfy this requirement.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C—** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).
2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.
3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully

complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog (https://catalog.vt.edu) for details.

Computational Modeling and Data Analytics Major with Physics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CMDA 3605	Mathematical Modeling: Methods and Tools *	3
CMDA 3606	Mathematical Modeling: Methods and Tools *	3
CMDA/CS 3634	Computer Science Foundations for Computational Modeling & Data Analytics *	3
CMDA/CS/STAT 3654	Introductory Data Analytics and Visualization *	3
CMDA/CS/STAT 4654	Intermediate Data Analytics and Machine Learning *	3
MATH 2114	Introduction to Linear Algebra *	3
Subtotal		18
Major Requirements		
CMDA 1634	Discovering Computational Modeling and Data Analytics *#	3
CMDA 2005	Integrated Quantitative Sciences *†	6
CMDA 2006	Integrated Quantitative Sciences *†	6
CS 1064	Introduction to Programming in Python *‡	3
CS 2064	Intermediate Programming in Python *‡	3
CS 2114	Software Design and Data Structures *	3
Subtotal		24
Option Required Courses		
PHYS 3324	Modern Physics *	4
PHYS 4755	Introduction to Computational Physics *	3
CMDA 4604	Intermediate Topics in Mathematical Modeling *	3
Subtotal		10
Elective Courses		
Select five of the following:		15
PHYS 3355	Intermediate Mechanics *	
PHYS 3405	Intermediate Electricity and Magnetism *	
PHYS 3406	Intermediate Electricity and Magnetism *	
PHYS 3704	Thermal Physics *	
PHYS 4455	Introduction to Quantum Mechanics *	
PHYS 4456	Introduction to Quantum Mechanics *	
PHYS 4534	Quantitative Analysis of Physics Experiments *	
PHYS 4554	Introduction to Solid State Physics *	
PHYS 4574	Nanotechnology *	
PHYS 4614	Optics *	
PHYS 4664	Astroparticle Physics *	
PHYS 4674	Introduction to General Relativity *	
PHYS 4714	Introduction to Biophysics *	
Subtotal		15
Free Electives		
Select remaining credits of free electives		4
Subtotal		4
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics	4
PHYS 2306	Foundations of Physics	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5f)	4
MATH 1226	Calculus of a Single Variable (5f)	4
CMDA 4864	Computational Modeling and Data Analytics Capstone Project (5a) *	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

* Courses will be used for computing the "in major" GPA.
† MATH 2204, MATH 2214, STAT 3005, STAT 3006 & STAT 3104 will substitute for CMDA 2005 & CMDA 2006.
‡ CS 1114 will substitute for (CS 1064 and CS 2064).
\# Any approved First Year Experience (FYE) course at Virginia Tech will satisfy this requirement.

Three conditions are required for continuation in the major:

1. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C—** or better in a maximum of two attempts (including attempts that were withdrawn): MATH 1225; MATH 1226; MATH 2114; (CMDA 2005 and CMDA 2006) or (STAT 3005, STAT 3006, STAT 3104; MATH 2204, MATH 2214).
2. Upon having attempted 72 total credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) majors must have completed the following courses with grades of **C** or better in a maximum of two attempts (including attempts that were withdrawn): (CS 1064 and CS 2064) or CS 1114; CS 2114.

3. Upon having attempted 12 credits of courses designated as counting for the in-major GPA (not including credits from withdrawn courses), students must maintain an in-major GPA of 2.0 or better.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in-major GPA and overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses have prerequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog (https://catalog.vt.edu) for more information.

Foreign Language Requirements

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog (https://catalog.vt.edu) for details.

Economics

Our Website (http://www.econ.vt.edu)

Overview

Economics is a social science that studies how people make decisions in order to pursue their goals in the best possible way and how this affects aggregate social outcomes. It studies how individuals, families, groups, markets behave as well as other types of formal and informal institutions and the interactions between them. Economists use mathematical modeling, data techniques and experimental methods to understand the causal underpinnings of behavior. Economic analysis is directed at a wide range of economy-wide problems including inflation and unemployment, monetary policy and interest rates and taxation decisions. Regulatory and antitrust problems, race relations and their history, environmental problems like greenhouse gas emission abatement, education and health policies are key policy questions tackled by economists. Statistical and econometric modeling, forecasting, big data techniques and using experiments for causal inference form an important part of the economist's toolkit. Individual decision-making, what drives cooperative behavior and altruism, managerial decision-making pricing and advertising behaviors of firms, voting and elections, strategic reasoning and several different types of logical paradoxes associated with human behavior fall within the purview of economics. Finally, economics also studies why some nations are richer than others, what drives sustainable development, international trade flows and the causes and consequences of globalization.

The Department of Economics at Virginia Tech not only has strengths in the core of areas of economics like microeconomics, macroeconomics and econometrics but also in new and emerging areas like Neuroeconomics, Decision Theory, Behavioral Economics and Big Data. Students can choose a variety of courses on topics like Development Economics, Health Economics, Economics of Gender and Race, Economic History of Race Relations, Game Theory, Economics of China and the Middle East, and the Application of R and Python to economics issues. Students opt for the regular degree in Economics or pursue a degree in Economics with the Business option. The Department strongly believes in providing all majors and minors individualized attention.

Specialization in economics prepares a person for a wide variety of careers that emphasize the methods and consequences of analytical decision-making in business and government and a broad understanding of the operation of the economy. Research shows that students with economics training perform better in cognitive tests. Economics prepares students for a variety of private sector jobs that require analytical skills including positions in consulting, marketing, data analytics, business analytics and finance. They are routinely employed in the federal, state, and local governments as well as in the non-profit sector and international organizations. Undergraduate education in economics also provides an excellent background for further study in law, political science, urban planning, and business administration.

Business Option

Science majors can declare a Business option which is designed to provide students an opportunity to explore introductory courses in traditional business subjects. It should be noted that this option is not a degree in the College of Business.

Managerial Economics and Data Science Option

This option is tailored toward students interested in careers in data science and consulting. This option provides students an opportunity to complete advanced courses in Math, Statistics, and Computer Science.

Policy and Regulation Option

This option is tailored toward students who are interested in careers in policy, non-profits, government agencies, and professional graduate degrees in law and public policy. This option provides students an opportunity to complete additional courses in Political Science, Urban Affairs and Planning, Philosophy, and Natural Resources.

Minor Requirements

The requirements to earn a minor in economics can be found on its checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

5-Year B.A. / M.A.

The department offers a 5-year combined bachelor's and master's degree for students with a GPA of at least 3.5. See the undergraduate advisor for details.

Honors Degree

The department also offers an honors degree. See the undergraduate advisor for details.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

- Economics Major (p. 1271)
- Economics Major with Business Option (p. 1272)
- Economics Major with Managerial Economics and Data Science Option (p. 1274)
- Economics Major with Policy and Regulation Option (p. 1276)

Chair: Sudipta Sarangi
Professors: R. Ashley, S. Ball, N. Bose, S. Ge, H. Haller, D. Salehi-Isfahani, S. Sarangi, A. Spanos, and T. N. Tideman
Associate Professors: E. Bahel, R. Cothren, A. Dominiak, X. Lin, A. Smith, K. Tsang, and J. Wooten
Assistant Professors: S. Barrera, A. Habibnia, M. Kovach, S. Luo, M. Miller, P. Tantihkarnchana, and B. Zhou
Professor Emeritus: A. Kats
Instructors: G. Gebremariam, M. Liu, and Z. Yang
Undergraduate Advising/Career Advisor: E. Perdue (231-7726)

Undergraduate Course Descriptions (ECON)

ECON 1004 - First Year Experience Seminar (1 credit)
The course focuses on supporting first-year students and first-semester transfer students to build relationships with faculty, upper class mentors, and each other to prepare them to enter a more significantly diverse and interdisciplinary dependent community. The course also focuses on building skills for students to create personal, academic, and career goals. The course also focuses on resume building opportunities for internships, research experiences, and graduate school.
Instructional Contact Hours: (1 Lec, 1 Crd)

ECON 1104 - Economics of Gender (3 credits)
Economic approach to the causes and consequences of male/female gender differences in economic outcomes. Tools in microeconomic analysis and empirical work. Woman, family choices and labor markets. Gender gap in earnings. Employment and wage policies related to women.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 1204 - Economics of Race (3 credits)
Causes and consequences of racial disparities in economic outcomes including education, health, housing, entrepreneurship, and earnings. Tools in microeconomics and statistics as applied to the study of racial issues. Historical and institutional contexts of racial problems. Change in racial gaps across generations. Impact of public policies to address racial discrimination in labor markets. Does not count toward ECON major.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 1214 - Economic History of Diversity and Inclusion (3 credits)
Economic analysis of topics concerning diversity and inclusion. Emphasis on Virginia and surrounding states. Introduction to the basic principles of economic analysis and economic history, with a special emphasis on models of institutional change, economic growth, discrimination, inequality, migration, and indigenous economic systems. Impact of institutions, environment, and technological change on labor markets, asset markets, and standard of living. Consideration of the role of data in understanding diversity and related ethical issues.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 1214

ECON 2005 - Principles of Economics (3 credits)
2005: Introduction to microeconomics. The economic approach to decision-making. Model of supply and demand. Elasticities. Consumer behavior. Firm behavior under varying industry structures. Sources and consequences of market failure. Costs and benefits of international trade. The role of government in the economy. Economic, ethical, and social ramifications of issues such as pollution, missing information, and income inequality. 2006: Introduction to macroeconomics. The measurement of economic activity. Macroeconomic problems (such as unemployment and inflation). The monetary system. Effects and limitations of monetary and fiscal policies. International economics. Social and ethical issues related to macroeconomic policy.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2006 - Principles of Economics (3 credits)
2005: Introduction to microeconomics. The economic approach to decision-making. Model of supply and demand. Elasticities. Consumer behavior. Firm behavior under varying industry structures. Sources and consequences of market failure. Costs and benefits of international trade. The role of government in the economy. Economic, ethical, and social ramifications of issues such as pollution, missing information, and income inequality. 2006: Introduction to macroeconomics. The measurement of economic activity. Macroeconomic problems (such as unemployment and inflation). The monetary system. Effects and limitations of monetary and fiscal policies. International economics. Social and ethical issues related to macroeconomic policy.
Prerequisite(s): ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2025H - Honors Principles of Economics (3 credits)
2025H: Microeconomics. Consumer behavior and demand, firm behavior and supply, price determination and market equilibrium under varying industry structure. Applications to labor and financial markets. 2026H: Macroeconomics. Measuring aggregate economic activity, macroeconomic problems (such as unemployment and inflation), the monetary system, effects and limitations of monetary and fiscal policies.
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2026H - Honors Principles of Economics (3 credits)
2025H: Microeconomics. Consumer behavior and demand, firm behavior and supply, price determination and market equilibrium under varying industry structure. Applications to labor and financial markets. 2026H: Macroeconomics. Measuring aggregate economics activity, macroeconomic problems (such as unemployment and inflation), the monetary systems, effects and limitations of monetary and fiscal policies.
Prerequisite(s): ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ECON 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 3004 - Contemporary Economic Issues (3 credits)
The economic analysis of current issues and problems. This course may be repeated with different topic.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3024 - Economic Justice (3 credits)
This course explores how different assumptions regarding the basis of claims for access to economic resources lead to different outcomes. Students will explore a variety of theories and examine their own beliefs about economic justice.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PPE 3024

ECON 3034 - Economics of Poverty and Discrimination (3 credits)
Poverty and inequality in the United States and around the world. Sources of poverty. Antipoverty policies. Definition, empirical evidence, and causes of discrimination. Emphasis on ethical human behavior and policy analysis.
Prerequisite(s): ECON 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3054 - Introduction to Forecasting (3 credits)
Provides an introduction to data-driven forecasting, with applications in economics and in other disciplines - e.g., political science and climatology. Specification, estimation, and validation of time-series regression models; ethical issues arising in model specification and estimation. Forecasting theory and evaluation.
Prerequisite(s): STAT 3005 or BIT 2405
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3104 - Microeconomic Theory (3 credits)
Theories of demand, production, perfectly and imperfectly competitive price determination, and general market equilibrium. Analytic applications.
Prerequisite(s): ECON 2005 and (MATH 1225 and MATH 1226) or ECON 2005 and (MATH 1025 and MATH 1026)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3134 - Choice and Behavior (3 credits)
Theories of rational choice, utility, and revealed preference. Intertemporal decision problems and choice under uncertainty with applications to insurance and investments. Behavioral regularities and evidence of violations of rational choice theory. Behavioral models that accommodate this behavior. Applications of behavioral models to economic problems, ethical questions, policy, and organization design. Pre: Sophomore standing.
Prerequisite(s): ECON 2005 or BDS 2005
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 3134

ECON 3144 - Economics of Regulation (3 credits)
Economics of regulation with a focus on U.S. laws and institutions. Market structures, mergers, antitrust laws, and anticompetitive behavior, including collusion and monopolization. Economic regulation of price, entry, and output. Incentive regulation and alternatives to regulation. Valuing life and other nonmonetary benefits. Regulation of health, safety, and the environment.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3154 - Managerial Economics (3 credits)
Applications of economic concepts and models to practical issues. Demand analysis, the law of demand, and different approaches to analyzing consumer behavior (elasticity, consumer surplus, and utility theory). Supply analysis, producer behavior, and theories of firms (diminishing returns, price takers and price searchers). Pricing strategies including segmentation, two-part tariffs, collusion, and predatory pricing. Market imperfections and extensions including signaling, adverse selection, network externalities, and the economics of time. Empirical analysis: formulating economic questions, finding and analyzing relevant data, and presenting findings to non-specialists.
Prerequisite(s): ECON 2006 or BDS 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3204 - Macroeconomic Theory (3 credits)
Theories of the determination of the level of aggregate economy-wide activity. Employment, the price level, aggregate national income, and the interest rate. The roles of money and expectations.
Prerequisite(s): (ECON 2006 or ECON 2026H) and (ECON 3104 or ECON 2025H) and (MATH 1226 or MATH 1526 or MATH 1026)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3214 - Money and Banking (3 credits)
Money and credit. The U.S. monetary system. Monetary theory, monetary policy and economic stabilization.
Prerequisite(s): (ECON 2005 or ECON 2025H) and ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3254 - Analysis of Economic Data (3 credits)
Sources of economic data. Application of spreadsheet and/or statistical software to analysis of economic relationships using graphical and regression techniques. Emphasis is on economic applications rather than statistical theory.
Prerequisite(s): STAT 3005 or STAT 3604 or STAT 3615 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006 or BIT 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3314 - Middle East Economics (3 credits)
Introduction to the economies of the Middle East and North Africa. Application of economic analysis to economic history and modern economic growth of the region. Historical role of a strong state and Islam in shaping the institutions of private property in Middle Eastern societies. The market for oil and the integration of the region into the global economy. The modern economy of the Middle East with focus on human capital development, inequality, and the role of women.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 3884 - Topics in Philosophy, Politics, and Economics (3 credits)
Topics-based course in philosophy, politics, and economics (PPE). Discussion of important topics and thinkers in PPE with historical and practical relevance. Focus on interdisciplinary analysis and methods. Topics include: limits of markets; well-being theory, science, and policy; socioeconomic justice; economic and political institutions; and global poverty. May be repeated 1 time with different content for a maximum of six credits hours. Pre: 3 credit hours in PPE, PHIL, PSCI, or ECON.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours
Course Crosslist: PHIL 3884, PPE 3884, PSCI 3884

ECON 3914 - European Economics (3 credits)
Microeconomics, macroeconomics and economic policies of the European Union. EU economic law, institutions, decision-making, and budgeting. Historic and current influences on regional economic development. Monetary and fiscal policies. Economic research methods, analysis, and reporting.
Prerequisite(s): ECON 2006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: IS 3914, PSCI 3914

ECON 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4014 - Environmental Economics (3 credits)
Economic dimensions and aspects of programs designed to impose quality controls upon the environment. Special emphasis on problems of controlling air and water pollution.
Prerequisite(s): ECON 2005 or ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4044 - Public Economics (3 credits)
Economic rationale of the public sector. Proper size and functions of government. Market failure, Cost-benefit analysis, public goods provision. Pricing of public enterprise services.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4054 - Public Finance (3 credits)
The structure and incidence of taxation in the U.S. Effects of taxes on incentives and economic efficiency. Tax Policy.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4074 - Labor Economics (3 credits)
Human capital theory, labor supply and demand, discrimination, effects of labor unions and collective bargaining, wage differentials, income distribution.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 3254 or ECON 4304)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4084 - Industry Structure (3 credits)
The structure and performance of American industry. Dimensions and measures of market structure. Factors affecting market structure. The relationship between structure and performance. Purpose and effects of antitrust policy, regulation, and other public policies toward industry.
Prerequisite(s): ECON 3104 or ECON 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4124 - Growth and Development (3 credits)
Theories of economic growth. Policies to foster growth, and their consequences.
Prerequisite(s): ECON 2006 and (ECON 2025H or ECON 3104)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4135 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4135

ECON 4136 - International Economics (3 credits)
4135 International Trade: Factor mobility and commercial policy (tariffs, quotas, export licensing). 4136 International Finance: Liquidity, exchange rates, comparative international living standards, foreign aid.
Prerequisite(s): ECON 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4144 - Economics of China (3 credits)
Evolution of the Chinese economy since 1949. Exposition of alternative economic systems, the commune, incentive problems, and state owned enterprises. Analysis of recent reforms and their effects on economic efficiency; and key issues of economic transition related to Russia and other East European countries.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4214 - Economics of Health Care (3 credits)
Effects of medical care on health; cost and production of medical care; demand for medical care and its financing; structure of the health care industry; reorganization for efficiency.
Prerequisite(s): ECON 2005 or ECON 2025H
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4304 - Introduction to Econometric Methods (3 credits)
An introduction to econometric modeling techniques, including regression methods. Particular emphasis on the special problems posed by economic data.
Prerequisite(s): ECON 3254 or STAT 3005 or STAT 4604 or STAT 4705 or STAT 4714 or CMDA 2006
Corequisite(s): ECON 3104, ECON 3204
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4314 - Big Data Economics (3 credits)
Applied econometrics dealing with big data. Theoretical, computational, and statistical underpinnings of big data analysis. The use of econometric models and deep machine learning algorithms to analyze the high-dimensional data sets. Implications in research focusing on economic questions that arise from rapid changes in data availability and computational technology. Materials are hands-on tutorials that come with Python codes and real-world data sets.
Prerequisite(s): ECON 3254 or ECON 4304 or CMDA 3654 or STAT 3006
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4314

ECON 4404 - Economics of Organizations (3 credits)
Economic theories of organization, with specific attention to their internal structure, and to design of incentive systems. Application to mergers, to the relationship between stockholders and managers, etc. Students with one year of economics, calculus and major in some other social science, by permission of the instructor.
Prerequisite(s): ECON 3104 or ECON 3154
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4424 - The Theory of Games and Economic Behavior (3 credits)
Introduction to games and solution concepts, such as prisoners dilemma, noncooperative equilibrium and Nashs bargaining solution. These concepts are applied in analyzing economic problems including bargaining problems, oligopoly and agency.
Prerequisite(s): ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4434 - Experimental Economics (3 credits)
This is a course in the use of laboratory methods to study behavior in economics and the social sciences. Students will study state-of-the-art methodology in experimental economics, including experimental design, laboratory technique, financial incentives, and analysis of data. Students will participate in, design, and conduct experiments in bargaining, auctions, asset markets, public goods and commons situations, and risky decision-making.
Prerequisite(s): ECON 3104 and (BIT 2406 or MSCI 2406 or STAT 2004 or STAT 3005)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: NEUR 4454, PSYC 4454

ECON 4514 - Applied Analysis of Banking and Financial Markets (3 credits)
Analysis of economic data with focus on understanding of decision-making in financial markets. Behavior of and optimal outcomes for individuals (consumption, savings, and investment), financial institutions (lending, borrowing, and risk management), regulators, and policy makers. Statistical tools and inference using recent data sets.
Prerequisite(s): ECON 3254 or ECON 4304
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4614 - R Programming in Economics (3 credits)
Using R to combine economic theory and data. Focus on general R programming fundamentals related to data science techniques and economic data (gathering, standardizing and cleaning, analysis, and visualization). Hands-on experience with a variety of data, data sources, and techniques within R. Flaws and limitations of data. Direct application with individual project combining economic theory and data using R.
Prerequisite(s): ECON 2005 and (ECON 3254 or ECON 4304)
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4754 - Internship (1-3 credits)
Qualified students are placed in an industry or government position under the combined supervision of a faculty member and a responsible supervisor in the employing agency. Satisfactory evaluation from employer, detailed reports on the internship experience and a specific project will be required of each intern. Pre: Junior standing, QCA of 2.50 or better and consent.
Prerequisite(s): (ECON 2005 or ECON 2025H) and (ECON 2006 or ECON 2026H)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 3 credit hours

ECON 4864 - Developing Behavioral Science Policies and Interventions (3 credits)
Senior-level capstone course to apply theories and models from behavioral decision science to real world problems on topics from education, organizations, health, crime, environment, and volunteerism. Utilize behavioral science theories, data and analytical frameworks from research papers to define and analyze problems or unintended consequences resulting from individual decision-making. Emphasis on identifying specific problems, formulating behavioral policies or interventions to improve performance, and designing experiments and randomized controlled trials to test their effectiveness.
Prerequisite(s): BDS 3134 or ECON 3134
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4864

ECON 4894 - Law and Economics (3 credits)
Analysis of the economic effects of legal rules, with emphasis on the law of property, contract, liability, and land use.
Prerequisite(s): ECON 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

ECON 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

ECON 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

ECON 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Economics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Courses in Degree Core Requirements must be completed with a grade of C- or better.		
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics (C-)	6
ECON 3104 & ECON 3204	Microeconomic Theory and Macroeconomic Theory (C-)	6
ECON 3254	Applied Econometrics (C-)	3
MATH 1226	Calculus of a Single Variable (C-)	4
STAT 3005	Statistical Methods (C-)	3
Subtotal		22
Major Requirements		
ECON 1004	First Year Experience Seminar	1
Subtotal		1
Major Requirements Electives		
Select five of the following		
ECON 3004	Contemporary Economic Issues	
ECON 3024	Economic Justice	
ECON 3034	Economics of Poverty and Discrimination	
ECON 3054	Introduction to Forecasting	
ECON 3134	Choice and Behavior	
ECON 3144	Economics of Regulation	
ECON 3154	Managerial Economics	
ECON 3214	Money and Banking	
ECON 3314	Middle East Economics	
ECON 3884	Topics in Philosophy, Politics, and Economics	
ECON 3914	European Economics	
ECON 4014	Environmental Economics	
ECON 4044	Public Economics	
ECON 4054	Public Finance	
ECON 4074	Labor Economics	
ECON 4084	Industry Structure	
ECON 4124	Growth and Development	
ECON 4135	International Economics	
ECON 4136	International Economics	
ECON 4144	Economics of China	
ECON 4214	Economics of Health Care	
ECON 4304	Introduction to Econometric Methods	
ECON 4314	Big Data Economics	
ECON 4404	Economics of Organizations	
ECON 4424	The Theory of Games and Economic Behavior	
ECON 4434	Experimental Economics	
ECON 4454	Neuroeconomics	
ECON 4514	Applied Analysis of Banking and Financial Markets	
ECON 4614	R Programming in Economics	
ECON 4714	Economics and Financing of State and Local Governments	
ECON 4864	Developing Behavioral Science Policies and Interventions	
ECON 4894	Law and Economics	
ECON 4994	Undergraduate Research	
Subtotal		15
Free Electives		
Select number of Free Electives sufficient to achieve 120 total credit hours		
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [1]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [2]		6
Pathways Concept 5 - Quantitative and Computational Thinking		*10*
MATH 1225	Calculus of a Single Variable (preferred; 5F) [3]	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) [3]		
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [4]		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		46
Total Credits		120

1. ECON 2005 Principles of Economics and ECON 2006 Principles of Economics cannot be used to satisfy this requirement since they are included in the Economics Common Degree Core Requirement.
2. To fulfill the Pathways Concept 4: Reasoning in the the Natural Sciences requirements, only approved BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC Pathways Concept 4 courses may be selected.
3. MATH 1225 Calculus of a Single Variable and MATH 1226 Calculus of a Single Variable must be completed with a minimum grade of C- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1025 Elementary Calculus and MATH 1026 Elementary Calculus must be completed with a minimum grade of B- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1226 Calculus of a Single Variable cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirements. MATH 1026 Elementary Calculus cannot be used to satisfy this requirement when used as a substitute for MATH 1226 Calculus of a Single Variable.

[4] STAT 3005 Statistical Methods cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirement. STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, and BIT 2406 Introduction to Business Statistics, Analytics, and Modeling cannot be used to satisfy this requirement if they are used as a substitute for STAT 3005 Statistical Methods.

Progress Toward Degree (Policy 91)

In order to remain in the Economics Major, students must meet the following requirements:

1. Upon having attempted 72 semester hours (including transfer, advanced placement, advanced standing, credit by examination, course withdrawal), students must have completed
   - ECON 2005 Principles of Economics (Micro) with a C- or better
   - ECON 2006 Principles of Economics (Macro) with a C- or better
   - ECON 3104 Microeconomic Theory with a C- or better
2. Upon having attempted 96 semester hours, students must have an In-Major grade point average of 2.000 or above and must have completed the above courses plus:
   - ECON 3204 Macroeconomic Theory with a C- or better
   - STAT 3005 Statistical Methods all with a C- or better
3. Students may not repeat any ECON course more than once, including late course withdrawals.
4. Students must register for at least three 3 credit ECON course during each academic year unless they have completed all ECON courses required for graduation.
5. Students may not repeat more than 3 ECON courses in the major.

A student who does not make satisfactory progress toward degree will be required to change their major out of Economics.

Graduation Requirements

Overall and In-Major GPA

Students must have a 2.0 overall GPA and 2.0 in-major GPA to graduate. Only ECON courses count toward the in-major GPA.

Free Electives

A free elective is any course a student takes toward the completion of the required minimum of 120 credit hours that does not complete a degree requirement. Students will complete a minimum number of free elective credit hours between 39-41 credit hours.

Total Hours Required

A minimum of 120 semester hours are required for graduation.

Acceptable Substitutions

STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling with at least C sub for STAT 3005 Statistical Methods.

MATH 1225 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1225 Calculus of a Single Variable and will be substituted.

MATH 1226 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1226 Calculus of a Single Variable.

MATH 1025 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1225 Calculus of a Single Variable.

MATH 1026 Elementary Calculus with AP credit of a grade of B- or better can be substituted for MATH 1226 Calculus of a Single Variable.

All ECON 4984, Special Studies, can be used for Option Required Courses Electives. Students may complete more than one course identified as a ECON 4984 Course ECON 4984 Not Found but cannot receive credit for the same ECON 4984 Course ECON 4984 Not Found more than once.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Economics Major with Business Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Courses in Degree Core Requirments must be completed with a grade of C- or better.		
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics (C-)	6
ECON 3104 & ECON 3204	Microeconomic Theory and Macroeconomic Theory (C-)	6
ECON 3254	Applied Econometrics (C-)	3
MATH 1226	Calculus of a Single Variable (C-)	4
STAT 3005	Statistical Methods (C-)	3
Subtotal		22
Major Requirements		
ECON 1004	First Year Experience Seminar	1
Subtotal		1
Major Requirements Restricted Electives		
Select five of the following [1]		
ECON 3144	Economics of Regulation	
ECON 3154	Managerial Economics	
ECON 3214	Money and Banking	
ECON 4074	Labor Economics	
ECON 4084	Industry Structure	
ECON 4135	International Economics	
ECON 4136	International Economics	
ECON 4214	Economics of Health Care	
ECON 4404	Economics of Organizations	
ECON 4424	The Theory of Games and Economic Behavior	
ECON 4514	Applied Analysis of Banking and Financial Markets	

ECON 4894	Law and Economics	
Subtotal		15
Option Required Courses		
Diverse Perspectives		
Select one of the following:		3
ECON 1104	Economics of Gender	
ECON 1204	Economics of Race	
ECON 1214	Economic History of Diversity and Inclusion	
Business Courses		
Select four from the following		12
ACIS 1504	Introduction to Business Analytics and Business Intelligence	
ACIS 2115	Principles of Accounting	
ACIS 2116	Principles of Accounting	
BIT 2405	Introduction to Business Statistics, Analytics, and Modeling (C)	
FIN 3054	Legal and Ethical Environment of Business	
or FIN 3074	Legal, Ethical, and Financing Issues for Entrepreneurs	
FIN 3104	Introduction to Finance	
HTM 2314	Introduction to International Business	
MGT 3304	Management Theory and Leadership Practice	
MKTG 3104	Marketing Management	
BIT 3414	Operations and Supply Chain Management	
Subtotal		15
Free Electives		
Select number of Free Electives sufficient to achieve 120 total credit hours.		
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [2]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		6
Pathways Concept 5 - Quantitative and Computational Thinking		*10*
MATH 1225	Calculus of a Single Variable (preferred; 5F) [4]	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) [4]		
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [5]		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [6]		3
Subtotal		46
Total Credit Hours		120

1. ECON 3004 Contemporary Economic Issues, ECON 4964 Field Study, ECON 4974 Independent Study, and ECON 4984 Special Study may be used as one of the required courses with approval from the department prior to the start of the semester in which the course is completed.
2. ECON 2005 Principles of Economics and ECON 2006 Principles of Economics cannot be used to satisfy this requirement since they are included in the Economics Common Degree Core Requirement. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used as one of two courses for three of six credits needed.
3. To fulfill the Pathways Concept 4: Reasoning in the the Natural Sciences requirements, only approved BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC Pathways Concept 4 courses may be selected.
4. MATH 1225 Calculus of a Single Variable and MATH 1226 Calculus of a Single Variable must be completed with a minimum grade of C- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1025 Elementary Calculus and MATH 1026 Elementary Calculus must be completed with a minimum grade of B- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1226 Calculus of a Single Variable cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirements. MATH 1026 Elementary Calculus cannot be used to satisfy this requirement when used as a substitute for MATH 1226 Calculus of a Single Variable.
5. STAT 3005 Statistical Methods cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirement. STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, and BIT 2406 Introduction to Business Statistics, Analytics, and Modeling cannot be used to satisfy this requirement if they are used as a substitute for STAT 3005 Statistical Methods.
6. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used for degree requirement.

Progress Toward Degree (Policy 91)

In order to remain in the Economics Major, students must meet the following requirements:

1. Upon having attempted 72 semester hours (including transfer, advanced placement, advanced standing, credit by examination, course withdrawal), students must have completed
   - ECON 2005 Principles of Economics (Micro) with a C- or better
   - ECON 2006 Principles of Economics (Macro) with a C- or better
   - ECON 3104 Microeconomic Theory with a C- or better
2. Upon having attempted 96 semester hours, students must have an In-Major grade point average of 2.0 or above and must have completed the above courses plus:
   - ECON 3204 Macroeconomic Theory with a C- or better
   - STAT 3005 Statistical Methods with a C- or better.
3. Students may not repeat any ECON course more than once, including late course withdrawals.

4. Students must register for at least three 3 credit ECON course during each academic year unless they have completed all ECON courses required for graduation.
5. Students may not repeat more than 3 ECON courses in the major.

A student who does not make satisfactory progress toward degree will be required to change their major out of Economics.

Graduation Requirements

Overall and In-Major GPA

Students must have a 2.0 overall GPA and 2.0 in-major GPA to graduate. Only ECON courses count toward the in-major GPA.

Free Electives

A free elective is any course a student takes toward the completion of the required minimum of 120 credit hours that does not complete a degree requirement. Students will complete a minimum number of free elective credit hours between 22-24 credit hours.

Total Hours Required

A minimum of 120 semester hours are required for graduation.

Note

Students who pursue the Economics – Business Option are not eligible to pursue a minor in business.

Acceptable Substitutions

1. STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers BIT 2406 Introduction to Business Statistics, Analytics, and Modeling with at least a C substitute for STAT 3005 Statistical Methods.
2. MATH 1225 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1225 Calculus of a Single Variable and will be substituted.
3. MATH 1226 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1226 Calculus of a Single Variable and will be substituted.
4. MATH 1025 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1225 Calculus of a Single Variable.
5. MATH 1026 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1226 Calculus of a Single Variable.
6. MGT 3404 Principles of Management for MGT 3304 Management Theory and Leadership Practice

Foreign Language Requirements

Foreign Language

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Economics Major with Managerial Economics and Data Science Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Courses in Degree Core Requirements must be completed with a grade of C- or better.		
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics (C-)	6
ECON 3104 & ECON 3204	Microeconomic Theory and Macroeconomic Theory (C-)	6
ECON 3254	Applied Econometrics (C-)	3
MATH 1226	Calculus of a Single Variable (C-)	4
STAT 3005	Statistical Methods (C-)	3
Subtotal		22
Major Requirements		
ECON 1004	First Year Experience Seminar	1
Subtotal		1
Major Requirements Restricted Electives		
Select five of the following:		
ECON 3054	Introduction to Forecasting	
ECON 3154	Managerial Economics	
ECON 4084	Industry Structure	
ECON 4304	Introduction to Econometric Methods	
ECON 4135	International Economics	
ECON 4136	International Economics	
ECON 4314	Big Data Economics	
ECON 4434	Experimental Economics	
ECON 4514	Applied Analysis of Banking and Financial Markets	
ECON 4614	R Programming in Economics	
Subtotal		15
Option Required Courses		
Diverse Perspectives		
Select one of the following:		3
ECON 1104	Economics of Gender	
ECON 1204	Economics of Race	
ECON 1214	Economic History of Diversity and Inclusion	
Data in Context		
Select two of the following: [1]		6
ECON/BDS 3134	Choice and Behavior	
ECON 3144	Economics of Regulation	
ECON 3214	Money and Banking	
ECON 4014	Environmental Economics	
ECON 4054	Public Finance	
ECON 4074	Labor Economics	
ECON 4214	Economics of Health Care	
ECON 4404	Economics of Organizations	
ECON 4424	The Theory of Games and Economic Behavior	
Analytical Reasoning		
Select two of the following:		6

CS 1064	Introduction to Programming in Python	
MATH 2114	Introduction to Linear Algebra	
MATH 2114H	Introduction to Linear Algebra	
MATH 2405H	Mathematics in a Computational Context	
STAT 3094	SAS Programming	
STAT 3104	Probability and Distributions	
STAT/CMDA/ CS 3654	Introductory Data Analytics and Visualization	
Subtotal		15
Free Electives		
Select number of Free Elective credits sufficient to achieve 120 total credit hours		
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [2]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		6
Pathways Concept 5 - Quantitative and Computational Thinking		*10*
MATH 1225	Calculus of a Single Variable (preferred; 5F) [4]	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) [4]		
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [5]		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [6]		3
Subtotal		46
Total Credit Hours		120

1. ECON 3004 Contemporary Economic Issues, ECON 4964 Field Study, ECON 4974 Independent Study, and ECON 4984 Special Study may be used as one of the required courses with approval from the department prior to the start of the semester in which the course is completed.
2. ECON 2005 Principles of Economics and ECON 2006 Principles of Economics cannot be used to satisfy this requirement since they are included in the Economics Common Degree Core Requirement. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used as one of two courses for three of six credits needed.
3. To fulfill the Pathways Concept 4: Reasoning in the the Natural Sciences requirements, only approved BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC Pathways Concept 4 courses may be selected.
4. MATH 1225 Calculus of a Single Variable and MATH 1226 Calculus of a Single Variable must be completed with a minimum grade of C- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1025 Elementary Calculus and MATH 1026 Elementary Calculus must be completed with a minimum grade of B- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1226 Calculus of a Single Variable cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirements. MATH 1026 Elementary Calculus cannot be used to satisfy this requirement when used as a substitute for MATH 1226 Calculus of a Single Variable.
5. STAT 3005 Statistical Methods cannot be used to satisfy this requirement since it is included in the Economics Degree Core Requirement. STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, and BIT 2406 Introduction to Business Statistics, Analytics, and Modeling cannot be used to satisfy this requirement if they are used as a substitute for STAT 3005 Statistical Methods.
6. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used for degree requirement.

Progress Toward Degree (Policy 91)

In order to remain in the Economics Major, students must meet the following requirements:

1. Upon having attempted 72 semester hours (including transfer, advanced placement, advanced standing, credit by examination, course withdrawal), students must have completed
   - ECON 2005 Principles of Economics (Micro) with a C- or better
   - ECON 2006 Principles of Economics (Macro) with a C- or better
   - ECON 3104 Microeconomic Theory with a C- or better
2. Upon having attempted 96 semester hours, students must have an In-Major grade point average of 2.0 or above and must have completed the above courses plus:
   - ECON 3204 Macroeconomic Theory with a C- or better
   - STAT 3005 Statistical Methods with a C- or better
3. Students may not repeat any ECON course more than once, including late course withdrawals.
4. Students must register for at least three 3 credit ECON course during each academic year unless they have completed all ECON courses required for graduation.
5. Students may not repeat more than 3 ECON courses in the major.

A student who does not make satisfactory progress toward degree will be required to change their major out of Economics.

Graduation Requirements

Overall and In-Major GPA

Students must have a 2.0 overall GPA and 2.0 in-major GPA to graduate. Only ECON courses count toward the in-major GPA.

Free Electives

A free elective is any course a student takes toward the completion of the required minimum of 120 credit hours that does not complete a degree

requirement.Students will complete a minimum number of free elective credit hours between 22-24 credit hours.

Total Hours Required

A minimum of 120 semester hours are required for graduation.

Acceptable Substitutions

1. STAT 3604 Statistics for Social Science , STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, BIT 2406 Introduction to Business Statistics, Analytics, and Modeling with at least a C substitute for STAT 3005 Statistical Methods
2. MATH 1225 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1225 Calculus of a Single Variable and will be substituted.
3. MATH 1226 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1226 Calculus of a Single Variable and will be substituted.
4. MATH 1025 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1225 Calculus of a Single Variable.
5. MATH 1026 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1226 Calculus of a Single Variable.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Economics Major with Policy and Regulation Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Courses in Degree Core Requirements must be completed with a grade of C- or better.		
ECON 2005 & ECON 2006	Principles of Economics and Principles of Economics (C-)	6
ECON 3104 & ECON 3204	Microeconomic Theory and Macroeconomic Theory (C-)	6
ECON 3254	Applied Econometrics (C-)	3
MATH 1226	Calculus of a Single Variable (C-)	4
STAT 3005	Statistical Methods (C-)	3
Subtotal		22
Major Requirements		
ECON 1004	First Year Experience Seminar	1
Subtotal		1
Major Requirements Restricted Electives		
Select five of the following: [1]		15
ECON 3024	Economic Justice	
ECON 3034	Economics of Poverty and Discrimination	
ECON 3144	Economics of Regulation	
ECON 3214	Money and Banking	
ECON 3314	Middle East Economics	
ECON 3914	European Economics	
ECON 4014	Environmental Economics	
ECON 4044	Public Economics	
ECON 4054	Public Finance	
ECON 4084	Industry Structure	
ECON 4124	Growth and Development	
ECON 4144	Economics of China	
ECON 4214	Economics of Health Care	
ECON 4894	Law and Economics	
Subtotal		15
Option Required Courses		
Diverse Perspectives		
Select one of the following:		3
ECON 1104	Economics of Gender	
ECON 1204	Economics of Race	
ECON 1214	Economic History of Diversity and Inclusion	
Policymaking		
Select four of the following:		12
COMM 2094	Communication and Issues of Diversity	
FREC/LAR/NR 2554	Leadership for Global Sustainability	
ECON 3004	Contemporary Economic Issues	
ECON 4754	Internship	
ECON 4964	Field Study	
ECON 4974	Independent Study	
ECON 4974H	Independent Study	
ECON 4994	Undergraduate Research	
ECON 4994H	Undergraduate Research	
GEOG 3244	The U.S. City	
GEOG 3844	European Geopolitics	
HIST 3554	Age of Globalization	
IS 2064	The Global Economy and World Politics	
IS 2114	Transatlantic Political Frameworks	
IS 3044	The Politics of Internet Governance	
IS 3154	Topics in Global Public Policies	
IS 3114	Global Security	
IS 3164	Global Trade: Structures and Policies	
IS 3174	Monetary Foundations of the World Economy	
IS 3554	Comparative Political Economy	
JMC 4334	Communication Ethics	
PHIL 2304	Global Ethics	
PSCI 2014	Introduction to Political Theory	
PSCI 2064	The Global Economy and World Politics	
PSCI 2074	Law and Politics	
PSCI 3554	Comparative Political Economy	
PSCI 3714	The U. S. Policy Process	
PSCI 3724	Poverty and Welfare Policy	
PSCI 3744	Public Policy Analysis	

PSCI 3854	European Political Economy	
SPIA 2554	Collaborative Policy-Making and Planning	
UAP 3224	Policy Implementation	
UAP 3354	Introduction to Environmental Policy and Planning	
UAP 3744	Public Policy Analysis	
UAP 4644	Washington Semester: Politics, Policy and Administration in A Democracy	
Subtotal		15
Free Electives		**21**
Select number of Free Electives sufficient to achieve 120 total credit hours		
Subtotal		21
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105 & ENGL 1106	First-Year Writing and First-Year Writing (1F)	6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03) [2]		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [3]		6
Pathways Concept 5 - Quantitative and Computational Thinking [4]		*10*
MATH 1225	Calculus of a Single Variable [4]	
Select three credits in Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F) [4]		
Select three credits in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A) [5]		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) [6]		3
Subtotal		46
Total Credits		**120**

1. ECON 3004 Contemporary Economic Issues, ECON 4964 Field Study, ECON 4974 Independent Study, ECON 4974H Independent Study, and ECON 4984 Special Study may be used as one of the required courses with approval from the department prior to the start of the semester in which the course is completed.
2. ECON 2005 Principles of Economics and ECON 2006 Principles of Economics cannot be used to satisfy this requirement since they are included in the Economics Common Degree Core Requirement. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used as one of two courses for three of six credits needed.
3. To fulfill the Pathways Concept 4: Reasoning in the the Natural Sciences requirements, only approved BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC Pathways Concept 4 courses may be selected.
4. MATH 1225 Calculus of a Single Variable - MATH 1226 Calculus of a Single Variable must be completed with a minimum grade of C- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1025 Elementary Calculus- MATH 1026 Elementary Calculus must be completed with a minimum grade of B- in each to satisfy the pre-req for ECON 3104 Microeconomic Theory. MATH 1226 Calculus of a Single Variable cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirements. MATH 1026 Elementary Calculus cannot be used to satisfy this requirement when used as a substitute for MATH 1226 Calculus of a Single Variable.
5. STAT 3005 Statistical Methods cannot be used to satisfy this requirement since it is included in the Economics Common Degree Core Requirement. STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4706 Probability and Statistics for Engineers, and BIT 2406 Introduction to Business Statistics, Analytics, and Modeling cannot be used to satisfy this requirement if they are used as a substitute for STAT 3005 Statistical Methods.
6. ECON 1104 Economics of Gender or ECON 1204 Economics of Race can be used for degree requirement.

Progress Toward Degree (Policy 91)

In order to remain in the Economics Major, students must meet the following requirements:

1. Upon having attempted 72 semester hours (including transfer, advanced placement, advanced standing, credit by examination, course withdrawal), students must have completed
   - ECON 2005 Principles of Economics (Micro) with a C- or better
   - ECON 2006 Principles of Economics (Macro) with a C- or better
   - ECON 3104 Microeconomic Theory with a C- or better
2. Upon having attempted 96 semester hours, students must have an In-Major grade point average of 2.0 or above and must have completed the above courses plus:
   - ECON 3204 Macroeconomic Theory with a C- or better
   - STAT 3005 Statistical Methods with a C- or better
3. Students may not repeat any ECON course more than once, including late course withdrawals.
4. Students must register for at least three 3 credit ECON course during each academic year unless they have completed all ECON courses required for graduation.
5. Students may not repeat more than 3 ECON courses in the major.

A student who does not make satisfactory progress toward degree will be required to change their major out of Economics.

Graduation Requirements

Overall and In-Major GPA

Students must have a 2.0 overall GPA and 2.0 in-major GPA to graduate. Only ECON courses count toward the in-major GPA.

Free Electives

A free elective is any course a student takes toward the completion of the required minimum of 120 credit hours that does not complete a

degree requirement. Students will complete a minimum number of 21 free elective credit hours.

Total Hours Required

A minimum of 120 semester hours are required for graduation.

Acceptable Substitutions

STAT 3604 Statistics for Social Science , STAT 3615 Biological Statistics , STAT 4706 Probability and Statistics for Engineers , BIT 2406 Introduction to Business Statistics, Analytics, and Modeling with at least a C sub for STAT 3005 Statistical Methods .

MATH 1225 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1225 Calculus of a Single Variable and will be substituted.

MATH 1226 Calculus of a Single Variable with AP or TR credit satisfies the minimum grade of C- or better for MATH 1226 Calculus of a Single Variable and will be substituted.

MATH 1025 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1225 Calculus of a Single Variable .

MATH 1026 Elementary Calculus with AP credit or a grade of B- or better can be substituted for MATH 1226 Calculus of a Single Variable .

Foreign Language Requirement

Foreign Language

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Geosciences

Our Website (http://www.geos.vt.edu)

Overview

Geosciences offer exciting opportunities for students with an interest in applying a diverse range of science skills to understand the earth's properties and dynamic processes. This is a highly interdisciplinary program that applies physics, chemistry, biology, computational techniques, and mathematics to understand and manage all aspects of Earth and the environment. Geoscientists work everywhere in the world under almost any condition as they search for earth resources, address environmental risks and natural hazards, and supervise technical and business enterprises. For more information about exciting careers in Geosciences consult **www.agiweb.org/careers.html**. The extensive scientific and quantitative skills of geoscientists, along with their broad field experience, allow them to pursue careers in many related fields ranging from material science to technical management and scientific reporting.

Virginia Tech's internationally recognized Geosciences faculty has developed six challenging options, described below, that lead to a B.S. in Geosciences. Coursework emphasizes the acquisition and processing of field data beginning with a special course in field methods taken in the spring of the first year. The geology option requires, and the other options recommend, that the student participate in a six-week field camp. The B.S. in Geosciences provides pre-professional preparation that will allow students to continue their education in post graduate programs in science, law, and business.

Earth systems and processes are enormously complicated and require a broad range of intellectual skills to decipher and manage. Geoscientists must possess strong quantitative skills and a solid understanding of physics, chemistry, and biology. They must be able to read maps, identify rocks, minerals, and fossils as well as visualize earth structures in three dimensions. They must have strong communication skills, both written and verbal. Learning to use these skills in an integrated way is a challenging and rewarding experience.

Geology Option

The Geology option offers a detailed coverage of the broad range of classic disciplines within the geosciences. This option emphasizes the study of minerals, rocks and fossils, and teaches the student how to understand the processes and history of the earth based on the occurrences and relationships of these materials at or near the Earth's surface.

Geochemistry Option

The Geochemistry option is designed for those students who have special interest in the fundamental chemical aspects of the Earth and its materials with applications to a broad range of geochemical and environmental problems.

Geophysics Option

The Geophysics option offers students the opportunity to specialize in the branch of the geosciences that investigates physical earth processes such as earthquakes and that images the interior of the earth through surface-based physical measurements.

Earth Science Education Option

The Earth Science Education option provides students with a broad Earth Science curriculum that meets the content goals for secondary earth science teaching. Certification for Earth Science teaching is not provided in the program. Information about teaching certification in Virginia can be obtained from the School of Education.

Environmental and Engineering Geosciences Option

The Environmental and Engineering Geosciences option is designed for students with interests in applying geosciences to solve problems related to human interaction with the natural environment and to apply geologic principles to engineering issues.

Geobiology and Paleobiology Option

The Geobiology and Paleobiology option is designed for students interested in studying the interactions between life and its environment in the modern Earth and ancient past (geobiology) and in reconstructing the biology and relationships of extinct life (paleobiology).

Minor in Geosciences

The requirements to earn a minor in Geosciences can be found on its checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

Graduate Program

The department offers M.S. and Ph.D. degrees in geosciences with specializations in many sub-disciplines. (See the Graduate Catalog (https://catalog.vt.edu/graduate/) for further information.)

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Geosciences with any of the available options can be found on the specific major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Geosciences Major with Earth Science Education Option (p. 1284)
- Geosciences Major with Environmental and Engineering Geoscience Option (p. 1285)
- Geosciences Major with Geobiology & Paleobiology Option (p. 1287)
- Geosciences Major with Geochemistry Option (p. 1288)
- Geosciences Major with Geology Option (p. 1291)
- Geosciences Major with Geophysics Option (p. 1292)

Head: W.S. Holbrook
University Distinguished Professors: R.J. Bodnar, P.M. Dove, G.V. Gibbs (Emeritus), and M.F. Hochella Jr. (Emeritus)
National Academy of Science: P.M. Dove
Professors: R.J. Bodnar, P.M. Dove, W.S. Holbrook, J.A. Hole, S.D. King, R.D. Law, N.L. Ross, M.E. Schreiber, J.A. Spotila, R. Weiss, and S. Xiao
Associate Professors: M.J. Caddick, B.C. Gill, F.M. Michel, S.J. Nesbitt, R.M. Pollyea, B.W. Romans, M. Shirzaei, D.S. Stamps, and Y. Zhou
Assistant Professors: G. Allen, M. Duncan, C. Dura, M.R. Stocker, S. Werth, and M. Willis
Research Professor: M.C. Chapman
Research Scientists: S. Bemis, R. Reid
Collegiate Associate Professor: J.A. Chermak
Senior Instructor: N.E. Johnson
Instructor: L.R. Neser
Adjunct Faculty: P. Prince, K. Weber, and W. Schmachtenberg
Affiliated Faculty: M. Murayama and S. Singerling

E-mail: geosciences@vt.edu

Undergraduate Course Descriptions (GEOS)

GEOS 1004 - Earth Science: Our Past, Present, and Future (3 credits)
Introduction to Earth science, including the fundamental concepts of geology in the modern context of humans interacting with the Earth. Formation and evolution of the Earth (history, plate tectonics, the rock cycle, geologic time), internal Earth dynamics (earthquakes, volcanoes, mitigating natural hazards), Earth materials (minerals and rocks, energy and mineral resources), surface processes (Earth system science, hydrologic cycle, global geochemical cycles, oceans and atmosphere, climate, erosion and landscapes), Earth sustainability (resources, environmental change), evaluating geological information and products of research, the scientific approach to problem solving, and the ethical issues associated with geoscience and the environment.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1014 - Evolution of the Earth-Life System (3 credits)
Introduction to the interaction of the Earths processes that shape our planet and its biosphere through time. Application of modern geoscientific inquiry; biological, chemical and physical interactions that are part of the Earth system; distribution of life on Earth (i.e., biogeography); diversity of life over time; the differentiation between science and pseudoscience; ethical issues around human activities and their impact on the Earth-Life system.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1024 - Earth Resources, Society, and Environment (3 credits)
Introduction to the Earths resources including their nature, formation, occurrence, extraction, distribution, consumption, and waste management and disposal using an integrated cradle to grave analysis. Population, the Earths metallic and non-metallic resources, rare earth elements, non-renewable and renewable energy and water. Social, environmental, economic and political impacts resource production and consumption have had historically, currently, and that are predicted into the future including current and future sources of energy in the United States and internationally. Sustainability, water abundance and quality, fracking, climate change, ocean acidification, and ozone depletion.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1034 - Earths Natural Hazards (3 credits)
Fundamentals of Earth processes that drive natural hazards, including earthquakes, volcanoes, tsunamis, hurricanes, tornadoes, floods, climate change and impacts with space objects; impacts of human activities on the Earth; defining and analyzing hazards and risks through testing hypotheses on geologic data; ethical issues arising from hazard mitigation; analysis of uncertainties of scientific information.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1054 - Age of Dinosaurs (3 credits)
Introduction to dinosaur paleontology, including fundamental geological and biological concepts, with focus on how modern paleontologists ask interdisciplinary questions to examine the fossil record. Use of dinosaurs to explore: process and impact of scientific method; geologic processes, geologic time, global change, ecosystems, biogeography; anatomy, evolution, biodiversity, phylogenetic relationships; and media portrayal of extinct animals.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1064 - Climate History: Past, Present, and Future (3 credits)
Introduction to the fundamental components of Earths climate system. Changes of Earths climate at different time scales. Climate change induced by plate tectonics, variations in Earths orbit and transition to and from ice ages. Historical and future changes of Earths climate. Climate models as tools to interpret climate data. Impacts of climate change. Climate ethics and policies.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 1104 - Introduction to Earth Sciences Laboratory (1 credit)
Introduction to Earth sciences laboratory, including identification of minerals and rocks, topographic and geologic maps, structural geology, geology impacting humans and humans impacting geology, environmental and social impacts.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

GEOS 1124 - Earth Resources, Society and Environment Laboratory (1 credit)
Laboratory course on Earths resources including their nature, importance, occurrence, extraction, and environmental, social, and political impacts of consumption. Earths resources include metal ores, non-metallic resources which includes surface and ground water and non-renewable (e.g., fossil fuels) and renewable energy (e.g., hydroelectric). Sustainability, water quality and quantity, climate change, and ocean acidification related to resource extraction and consumption.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lab, 1 Crd)

GEOS 2004 - Geosciences Career and Professional Development (3 credits)
Introduction to career and professional development in the geosciences, including investigating career options, searching for internships and jobs, discussing topics of ethics, diversity and inclusion, evaluating information resources, collaborating in research groups, and developing skills in technical communication. Restricted to geoscience majors.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 2014 - Mission to the Planets (3 credits)
The events and processes that shaped the terrestrial planets; the scientific method (i.e., observations, techniques, and theories) that supports our understanding of these events and processes; the role of science, politics, and engineering and how these impact planetary science missions; ethical issues associated with planetary research; manned and unmanned exploration and how they have shaped our understanding of the planets.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 2024 - Earth's Dynamic Systems (6 credits)
Overview of the geosciences, emphasizing processes operating within and on the Earth now and over the last 4.55 billion years. Earth's systems, cycles and material. Earth's formation, the physical Earth, and plate tectonics. Earth's record, including the fossil record, evolution, origin and diversity of life, and biogeography. History of the Earth-Life system, including key events throughout time. Time and length scales. Climate change and extinction. Field trips required. Restricted to geoscience majors (5H, 3L, 6C), partial duplication of GEOS 1004.
Instructional Contact Hours: (5 Lec, 3 Lab, 6 Crd)

GEOS 2104 - Elements of Geology (3 credits)
Structure of the earth, properties of minerals and rocks, and geologic processes that act on the surface and in the interior of the earth, and integrated geologic systems of importance in engineering and regional planning. For students in engineering and physical sciences. Geology 2104 duplicates material in Geology 1004 and both may not be taken for credit.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 2444 - Geoscience Field Observations (3 credits)
Study of geological processes in the field. Integration of field observations with datasets into conceptual geological interpretations and models. Identification of rock type, lithology and structure in outcrop.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

GEOS 2984 - Special Study (1-10 credits)
Instructional Contact Hours: (1-10 Lec, 1-10 Crd)

GEOS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 3014 - Environmental Geosciences (3 credits)
The roles of geology and geophysics in defining and monitoring the natural environment, with special application to interactions between humans and the geologic environment. Both descriptive treatment and quantitative concepts related to environmental processes involving the solid earth and earths surface, with emphasis on geologic hazards (e.g., earthquakes, volcanoes, landslides and slope failures, flooding, groundwater problems, mineral and rock dusts).
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3024 - Computational Methods in the Geosciences (3 credits)
Development of computational skills aimed at extracting pertinent trends and significance of a wide variety and quantity of highly heterogeneous geoscience data; application of analytical, statistical and signal processing methods for analyzing time-series, spatial and satellite imagery data; tools for producing publication quality maps, graphs, charts, and other visual aids.
Prerequisite(s): MATH 1225 or MATH 1025
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3034 - Oceanography (3 credits)
Descriptive and quantitative treatment of the geological, physical, chemical and biological processes that occur in, or are influenced by, the oceans. The history of oceanic exploration and discovery is addressed.
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3044 - Geosciences Outreach (2 credits)
Service-learning through teaching. Identification and development of geoscience outreach activities based on national and state science education standards. Assessment methods for evaluating the effectiveness of outreach activities. Techniques for effective instructional design and communication of geoscience concepts to enrich the general publics awareness of the geosciences.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014)
Instructional Contact Hours: (2 Lec, 2 Crd)

GEOS 3104 - Elementary Geophysics (3 credits)
Acquisition and interpretation of exploration geophysical data. Seismic reflection and refraction methods, gravity and magnetic fields, geoelectrical methods, and geophysical well logging.
Prerequisite(s): (GEOS 1004 or GEOS 2024 or GEOS 2104) and (MATH 1026 or MATH 1226) and (PHYS 2205 or PHYS 2305)
Corequisite(s): PHYS 2206 or PHYS 2306
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3204 - Sedimentology-Stratigraphy (3 credits)
Study of sedimentary basins in a plate-tectonic framework, mechanisms of basin formation, three-dimensional geometry of basin fill, and controls on basin fill. Siliciclastic and carbonate-evaporate rocks as examples of basin fill are discussed in lectures and studied in the lab and in the field. Applied aspects of the course include a discussion of geometries of sedimentary aquifers and reservoirs.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3304 - Geomorphology (3 credits)
Examines the variety of landforms that exist at the earths surface. Detailed investigation of major processes operating at the earths surface including: tectonic, weathering, fluvial, coastal, eolian, and glacial processes. Field excursion.
Prerequisite(s): GEOG 1104 or GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3304, GEOG 3304

GEOS 3404 - Elements of Structural Geology (3 credits)
Introduction to basic geological structures, evolution of microfabrics, development of faults, folds and foliations, stereographic analysis of geological structures, thrust fault geometries, balancing of geological cross-sections, and introduction to the concepts of stress and strain.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3504 - Mineralogy (3 credits)
Principles of modern mineralogy, crystal chemistry, and crystallography, with emphasis on mineral atomic structure and physical property relationships, mineralogy in the context of geology, geochemistry, environmental science and geophysics, phase equilibria, mineral associations, and mineral identification, and industrial applications of minerals. There are three required field trips during the semester.
Prerequisite(s): CHEM 1035 or CHEM 1055 or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: MSE 3104

GEOS 3604 - Paleontology (3 credits)
Paleontological principles and techniques and their application to the evolution of life, the ecological structure of ancient biological communities, the interpretation of ancient depositional environments, and the history of the earth.
Prerequisite(s): (GEOS 1004 and GEOS 1014) or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3614 - Soils (3 credits)
Characterization of soils as a natural resource emphasizing their physical, chemical, mineralogical, and biological properties in relation to nutrient availability, fertilization, plant growth, land-use management, waste application, soil and water quality, and food production. For CSES, ENSC, and related plant- and earth-science majors. Partially duplicates CSES/ENSC 3134.
Prerequisite(s): CHEM 1036
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CSES 3114

GEOS 3624 - Soils Laboratory (1 credit)
Parent materials, morphology, physical, chemical, and biological properties of soils and related soil management and land use practices will be studied in field and lab. Partially duplicates CSES/ENSC 3134.
Corequisite(s): GEOS 3614
Instructional Contact Hours: (3 Lab, 1 Crd)
Course Crosslist: CSES 3124

GEOS 3634 - Natural History Collections and Curation (3 credits)
Introduction to museums and natural history collections, with a focus on hands-on curation of specimens to learn standard archival practices and principles. Exploration of campus collections such as the Museum of Geosciences, Massey Herbarium, and Cheatham Vertebrate Collection with particular focus on: specimen acquisition and accessioning; specimen preparation, preservation, and identification; collection labeling, organization, and storage; collection management databases; metadata; emergency response plans; and the role of museums over time for outreach and interpretation. Application of knowledge through final project.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014) or (BIOL 1105 and BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 3644 - Paleontological Laboratory Techniques (2 credits)
Laboratory techniques for extracting and preserving paleontological data. Tracing the process a fossil goes through from the field until it is permanently curated. Supervised hands-on experience in an active paleontological laboratory. Independent paleontology information preservation projects. Topics include: philosophy of fossil preparation, mechanical and chemical preparation, conservation and lab materials, digital data and virtual preparation, molding and casting, 3D printing, and collaboration with other museums.
Prerequisite(s): GEOS 1014 or GEOS 1054 or GEOS 2024
Instructional Contact Hours: (2 Lec, 2 Crd)

GEOS 3704 - Igneous and Metamorphic Rocks (3 credits)
Study of characteristics and mechanisms of igneous intrusion at depth in the crust, volcanic phenomena on the surface, and textural and mineralogical modification of rocks at elevated temperatures and pressures of crustal metamorphism. Tectonic aspects of igneous and metamorphic rocks will be stressed.
Prerequisite(s): GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

GEOS 3954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4024 - Senior Seminar (3 credits)
Integration and solution of significant geoscience research problems and case studies by analysis and integration of information across a wide spectrum of geoscience sub-disciplines. Techniques for effective oral and written communication of technical information to experts and non-experts. Independent and team research projects. Analysis of ethics associated with societally-relevant geosciences issues. Ethics and professionalism in geosciences.
Prerequisite(s): GEOS 2004 and GEOS 2024 and GEOS 2444 and GEOS 3204 and GEOS 3404 and GEOS 3504
Pathway Concept Area(s): 1A Discourse Advanced, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4084 - Modeling with Geographic Information Systems (3 credits)
Use of automated systems for geographic data collection, digitization, storage, display, modeling and analysis. Basic data flow in GIS modeling applications. Development of proficiency in the use of current GIS software. Senior Standing.
Prerequisite(s): GEOG 2084
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Course Crosslist: GEOG 4084

GEOS 4124 - Seismic Stratigraphy (3 credits)
Overview of seismic data acquisition and processing methods, seismic wavelets, static and dynamic corrections, and seismic velocities; seismic reflection data interpretation; seismic reflection responses Seismic mapping; seismic stratigraphy and seismic lithology. Consent required.
Prerequisite(s): GEOS 3104 and GEOS 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4134 - Interdisciplinary Issues and Ethics in Water Resources (3 credits)
Analysis of issues and ethics related to water resources, water as a hazard upon human (infrastructure, economy) and ecological (rivers, groundwater) systems, water and vector borne disease, climate change, dams, and eutrophication. Development of proficiency in demonstrating the multidimensionality of water resources. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: GEOG 4134

GEOS 4154 - Earthquake Seismology (3 credits)
Seismicity and its causes in the context of plate tectonics; determination of earthquake location, size and focal parameters; seismogram interpretation; seismometry; hazard potential; use of earthquakes in determining earth structure.
Prerequisite(s): MATH 2204 or MATH 2204H and MATH 2214 and PHYS 2305 and GEOS 3104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4164 - Potential Field Methods in Exploration Geophysics (4 credits)
Theory and application to engineering, environmental, and resource exploration. Gravity, magnetics, electrical resistivity, self potential, induced polarization, ground-penetrating radar, magnetotellurics, electromagnetic induction.
Prerequisite(s): (MATH 2204 or MATH 2204H) and MATH 2214 and PHYS 2306 and GEOS 3104
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4174 - Exploration Seismology (4 credits)
Theory and application of seismic methods to engineering, environmental and resource exploration: reflection seismics, refraction seismics, and tomography. Data acquisition, digital filtering, data corrections, imaging, interpretation, and forward modeling.
Prerequisite(s): MATH 2204 or MATH 2204H and MATH 2214 and PHYS 2305 and GEOS 3104
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4184 - Geodesy in the Earth Sciences (3 credits)
Study of measurement of Earth 's geometric shape, orientation in space, the gravity field, and how these properties change over time. Geodetic methods of measurement (i.e., GNSS, InSAR, TLS, gravity). Reference frames, geodetic applications, and geodetic advances.
Prerequisite(s): GEOS 1004 or GEOS 1024 or GEOS 1034 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4234 - Vertebrate Evolution (4 credits)
Characterization of the evolution of vertebrates from the fossil record to now. Tracing anatomical features in humans to their origin of different vertebrate groups. Chronicling vertebrate diversification events through extinctions, changes in climate in the last 600 million years, biogeography, and phylogenetic methods. Evidence of evolution through fossils and dissection.
Prerequisite(s): GEOS 1014 or BIOL 2704 or GEOS 2024
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4244 - Morphology of the Vertebrates (4 credits)
Identification of skeletal osteological elements of major groups of vertebrates, including aspects of skeletal functional morphology and homology, with emphasis on extant taxa. Skeletal systems of model and non-model organisms such as fish, amphibians, reptiles, birds, and mammals; specimen care and data management; modern skeletal collection practices.
Prerequisite(s): (GEOS 1014 or GEOS 2024 or GEOS 1054) or (BIOL 1105 and BIOL 1106)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4254 - Integrative Earth System History (3 credits)
Study of Earth system evolution, with a focus on critical transitions that shaped the history of the Earth, and the integration and interaction of the atmosphere, hydrosphere, biosphere, and geosphere. Principles of system science, box models, atmospheric and oceanographic processes, microbial processes, isotopic tracers, elemental cycles, and critical transitions in Earth history, including the origin of life, changes in atmospheric composition, climatic events and mass extinctions.
Prerequisite(s): GEOS 2024 or (GEOS 1004 and GEOS 1014) or (GEOS 2104 and GEOS 1014)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4264 - Sedimentary Basins (3 credits)
Formation, evolution, and characterization of regions of the Earths surface that experience long-lived subsidence and sediment accumulation. Integration of concepts and skills from: stratigraphy, surface processes, tectonics, structural geology, burial/thermal history, geo/thermochronology, and geodynamics; content is relevant to fields such as paleontology, (paleo)climatology, and subsurface resource management. Use of programming/statistical software packages.
Prerequisite(s): GEOS 3204
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4314 - Coastal Hazards (3 credits)
Study of past, current, and future drivers of coastal change and hazards. Integration of concepts and skills from: climatic, isostatic, and tectonic processes that drive sea-level change; geologic (e.g., coastal stratigraphy, microfossils) and instrumental (e.g., tide gauges, satellite altimetry) coastal change reconstructions, models, measurements, and projections. Coastal earthquake, tsunami, hurricane, and storm-surge hazards. Approaches and challenges of communicating coastal hazards to the public. Coastal hazards and public policy.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4354 - Introduction to Remote Sensing (3 credits)
Theory and methods of remote sensing. Practical exercises in interpretation of aerial photography, satellite, radar and thermal infrared imagery. Digital analysis, image classification and evaluation. Applications in earth sciences, hydrology, plant sciences, and land use studies.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: GEOG 4354

GEOS 4404 - Advanced Structural Geology (3 credits)
Basic principles of rock behavior under applied, non-hydrostatic stress (experimental and tectonic) and analysis of the geometrical patterns produced. Alternate years.
Prerequisite(s): GEOS 3404
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4614 - Stable Isotope Biogeochemistry (3 credits)
Introduction to the fundamental processes that drive the sorting of carbon, nitrogen, oxygen, hydrogen, and sulfur stable isotopes in modern and past marine and terrestrial systems. Application of stable isotopes to address research questions in a variety of disciplines, including geology, paleobiology, ecology, and environmental sciences. Collect, prepare, analyze, and interpret stable isotope data.
Prerequisite(s): CHEM 1035 or CHEM 1055 or CHEM 1055H
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4624 - Mineral Deposits (3 credits)
Introduction to the range and variety of metallic and non-metallic economic mineral deposits. Classification of the petrologic and tectonic settings of mineral deposits. Source, transport and depositional mechanisms of mineral deposit formation. Laboratory emphasizes identification of ore minerals, gangue minerals, common host rocks, wall-rock alteration and mineral zoning. Course requirement of 3 hours of GEOS at the 3000-level or above, may be satisfied by taking prerequisite prior to or concurrent with course.
Prerequisite(s): GEOS 1004 or GEOS 2104 or GEOS 2024
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4634 - Environmental Geochemistry (3 credits)
Application of quantitative methods of thermodynamic and physicochemical analysis to the study of the distribution and movement of chemical elements in surface and near-surface geological environments. Emphasis on practical approaches to environmental geochemistry.
Prerequisite(s): (MATH 1225 or MATH 1025) and (CHEM 1035 or CHEM 1055) or (ISC 1106 and ISC 1116)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4714 - Volcanoes and Volcanic Processes (3 credits)
Study of characteristics and mechanisms of volcanic phenomena, including magma dynamics, origin and chemistry of lavas, physics of eruptions, and characteristics of volcanic products, particularly pyroclastic deposits. Includes focus on volcanism as a general planetary process, on terrestrial tectonic settings of volcanism and on volcanic hazards.
Prerequisite(s): GEOS 1004 or GEOS 2024 or GEOS 2104
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4804 - Groundwater Hydrology (3 credits)
Physical principles of groundwater flow, including application of analytical solutions to real-world problems. Well hydraulics. Geologic controls on groundwater flow.
Prerequisite(s): (MATH 1226 or MATH 1026) and (PHYS 2205 or PHYS 2305)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

GEOS 4824 - Engineering Geology (3 credits)
Application of geological, geochemical, and hyrdogeological principles to engineering problems; relating rock and soil forming processes to engineering properties of geological materials; physical and chemical weathering processes and relationships with engineering properties of soil and rock; effective stress theory and geologic hazards; methods and data types for environmental applications and engineering works; geologic hazards and human-land interactions; professionalism and ethics in the practice of engineering geology.
Prerequisite(s): (GEOS 1004 or GEOS 2024 or GEOS 2104) and (PHYS 2305 or PHYS 2205) and (CHEM 1035 or CHEM 1015) and (MATH 1225 or MATH 1025)
Instructional Contact Hours: (3 Lec, 3 Crd)

GEOS 4924 - Tectonics (4 credits)
Overview of modern plate tectonic theory and history. Physical processes driving present-day plate tectonic deformation including continental rifts, rifted margins, continental transforms, strike-slip faults, subduction zones and orogenic belts. Plate kinematic concepts and information about the Earth's structure. Application of scientific method, data analysis, and computational modeling.
Prerequisite(s): (MATH 1025 or MATH 1225) and (PHYS 2205 or PHYS 2305)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

GEOS 4944 - Study Abroad Topics in Geosciences (1-3 credits)
Study of geoscience topics in a global environment. Cross#cultural perspectives on scientific inquiry and knowledge in the geosciences. Application to topics of societal relevance. Field experiences in places of geologic, societal and cultural interest. Specific topics may vary from semester to semester. May be repeated with different content for a maximum of 9 credit hours.
Prerequisite(s): GEOS 2024 or GEOS 2104 or (GEOS 1004 and GEOS 1104)
Instructional Contact Hours: (1-3 Lec, 1-3 Crd)
Repeatability: up to 9 credit hours

GEOS 4954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

GEOS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

GEOS 4994 - Undergraduate Research (1-19 credits)
May be repeated for a maximum of 4 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 4 credit hours

GEOS 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Geosciences Major with Earth Science Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	2
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		20
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
Select one of the following:		10-12
Sequence 1		
MATH 1025	Elementary Calculus [3]	
MATH 1026	Elementary Calculus [3]	
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory [3]	
Sequence 2 (preferred)		
MATH 1225	Calculus of a Single Variable [3]	
MATH 1226	Calculus of a Single Variable [3]	
PHYS 2305	Foundations of Physics [3]	
Subtotal		10-12
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory [3]	4
GEOG 1514	Introduction to Meteorology	3
EDEP 2444	Motivating Yourself and Others [3]	3
or HD 1004	Childhood and Adolescence	
or PSYC 1004	Introductory Psychology	
EDCI 3024	Issues of Schooling in the United States [3]	3
PHYS 1055	Introduction to Astronomy [3]	3
or GEOS 2014	Mission to the Planets	
GEOS 1024	Earth Resources, Society, and Environment [3]	3
or GEOS 1064	Climate History: Past, Present, and Future	
GEOS 3034	Oceanography	3
GEOS 3014	Environmental Geosciences	3
GEOS 3044	Geosciences Outreach	2
Subtotal		27
Select one of the following:		4
CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory [3]	
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory [3]	
PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory [3]	
or PHYS 230	Foundations of Physics	
Subtotal		4
Elective Courses		
GEOS 3XXX-4XXX	Geosciences Elective [2]	14-15
Subtotal		14-15
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement (Students may need to complete less credit hours in this category depending on choices in categories above)		11
Subtotal		11
Pathways to General Education [4]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Pathways Concept 3 - Reasoning in the Social Sciences completed by major/option requirements		
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3

Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States completed by major/option requirements	
Subtotal	18
Total Credits	**120-123**

Footnotes

[1] Credits may double-count for Major Requirements and Pathways.
[2] See University Course Catalog for prerequisites.
[3] Credits may double-count for Option Requirements and Pathways.
[4] If requirements completed as outlined, **27 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/.

Satisfactory Progress Toward Degree (Policy 91)

1. By 45 hours attempted at Virginia Tech, students must have completed the following courses:
   - GEOS 2004
   - GEOS 2024 (or GEOS 1004 and GEOS 1104 and GEOS 1014 or GEOS 2104 and GEOS 1014)
   - GEOS 2444
   - GEOS 3504
   - MATH 1025 or MATH 1225
   - CHEM 1035
   - CHEM 1045
2. By 60 hours attempted at Virginia Tech, students must have completed the following courses:
   - PHYS 2205 and PHYS 2215 or PHYS 2305
3. Students must achieve an overall GPA of 2.0 and an in-major GPA of 2.5 upon attempting 15 GEOS credit hours (including transfer credit, courses completed with a grade of "W", advanced placement or IB credit)

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.5 or greater. The in-major GPA is calculated from all GEOS courses.

Prerequisites

There are no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Even when listed, prerequisites are subject to change. Please consult University Catalog for current information.

Acceptable Substitutions

- GEOS 1004, and GEOS 1104, and GEOS 1014 for GEOS 2024
- GEOS 2104 and GEOS 1014 for GEOS 2024
- CHEM 1055 or CHEM 1055H for CHEM 1035
- CHEM 1065 for CHEM 1045
- COMM 1015 for ENGL 1105
- COMM 1016 for ENGL 1106

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

1.

Geosciences Major with Environmental and Engineering Geoscience Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	3
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		21
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005 or STAT 3615	Statistical Methods [1] Biological Statistics	3
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
MATH 1225	Calculus of a Single Variable [2]	4
MATH 1226	Calculus of a Single Variable [2]	4
PHYS 2305	Foundations of Physics [2]	4
PHYS 2306	Foundations of Physics [2]	4
CHEM 1036	General Chemistry [2]	3
CHEM 1046	General Chemistry Laboratory [2]	1
GEOS 3014	Environmental Geosciences	3
GEOS 3104	Elementary Geophysics	3
GEOS 3304	Geomorphology	3
GEOS 4804	Groundwater Hydrology	3
GEOS 4824	Engineering Geology	3
Subtotal		35

Elective Courses		
Select a minimum of 14 credits of the following:		14
GEOS 3614/ CSES 3114	Soils	
GEOS 3624/ CSES 3124	Soils Laboratory	
GEOS 3704	Igneous and Metamorphic Rocks	
GEOS/GEOG 4084	Modeling with Geographic Information Systems	
GEOS 4164	Potential Field Methods in Exploration Geophysics [3]	
GEOS 4174	Exploration Seismology [3]	
GEOS/GEOG 4354	Introduction to Remote Sensing	
GEOS 4404	Advanced Structural Geology	
GEOS 4624	Mineral Deposits	
GEOS 4634	Environmental Geochemistry	
GEOS 4944	Study Abroad Topics in Geosciences (max 4 credits)	
or GEOS 4954	Study Abroad	
GEOS 4964	Field Study (1-6 credits)	
GEOS 4994	Undergraduate Research (max 3 credits)	
CSES 3614	Soil Physical and Hydrological Properties	
ENSC 3634	Physics of Pollution [3]	
FREC/WATR 3104	Principles of Watershed Hydrology	
Subtotal		14
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement		7
Subtotal		7
Pathways to General Education [4]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/ option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation and Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		27
Total Credits		**120**

1. Credits may double-count for Major Requirements and Pathways.
2. Credits may double-count for Option Requirements and Pathways.
3. Additional prerequisite not required for major/option is needed for this course.
4. If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Satisfactory Progress Toward Degree (Policy 91)

1. By 45 hours attempted at Virginia Tech, students must have completed the following courses:
   - GEOS 2004 Geosciences Career and Professional Development
   - GEOS 2024 Earth's Dynamic Systems (or GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014 Evolution of the Earth-Life System)(or GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System)
   - GEOS 2444 Geoscience Field Observations
   - GEOS 3504 Mineralogy
   - MATH 1225 Calculus of a Single Variable
   - CHEM 1035 General Chemistry
   - CHEM 1045 General Chemistry Laboratory
2. By 60 hours attempted at Virginia Tech, students must have completed the following course:
   - PHYS 2305 Foundations of Physics
3. Students must achieve an overall GPA of 2.0 and an in-major GPA of 2.5 upon attempting 15 GEOS credit hours (including transfer credit, courses completed with a grade of "W", advanced placement or IB credit)

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.5 or greater. The in-major GPA is calculated from all GEOS courses.

Prerequisites

Prerequisites are listed on the checksheet. There are no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Even when listed, prerequisites are subject to change. Please consult University Course Catalog for current information.

Acceptable Substitutions

- GEOS 1004 and GEOS 1104 and GEOS 1014 for GEOS 2024
- GEOS 2104 and GEOS 1014 for GEOS 2024

- CHEM 1055 or CHEM 1055H for CHEM 1035
- CHEM 1056 or CHEM 1056H for CHEM 1036
- CHEM 1065 for CHEM 1045
- CHEM 1066 for CHEM 1046
- COMM 1015 for ENGL 1105
- COMM 1016 for ENGL 1106
- GEOS 4974for GEOS 4994

Foreign Language

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

1.

Geosciences Major with Geobiology & Paleobiology Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	2
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		20
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
Select one sequence of the following:		10-12
Sequence 1		
MATH 1025	Elementary Calculus [2]	
MATH 1026	Elementary Calculus [2]	
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory [2]	
Sequence 2 (preferred)		
MATH 1225	Calculus of a Single Variable [2]	
MATH 1226	Calculus of a Single Variable [2]	
PHYS 2305	Foundations of Physics [2]	
Subtotal		10-12
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory [2]	4
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory [2]	4
BIOL 2704	Evolutionary Biology	3
STAT 4094	Introduction to Programming in R	1
GEOS 3044	Geosciences Outreach	2-3
or COMM 2004	Public Speaking	
or COMM 2014	Speech Communication	
GEOS 3604	Paleontology	3
GEOS 4254	Integrative Earth System History	3
GEOS 4234	Vertebrate Evolution	4
or GEOS 4244	Morphology of the Vertebrates	
GEOS 4964	Field Study	6
or GEOS 3634 & GEOS 3644 & GEOS 4994	Natural History Collections and Curation and Paleontological Laboratory Techniques and Undergraduate Research	
Subtotal		30-31
Elective Courses		
Select two of the following:		6-8
BIOL 2004	Genetics	
BIOL/HORT 2304	Plant Biology	
BIOL 2504	General Zoology	
BIOL 2604	General Microbiology	
BIOL 3204	Plant Taxonomy	
ENT/BIOL 4354	Aquatic Entomology	
BIOL 4404	Ornithology	
FIW 4424	Ichthyology	
FIW 4334	Mammalogy	
FIW 4344	Herpetology	
GEOS 4944	Study Abroad Topics in Geosciences (max 6 credits)	
GEOS 4954	Study Abroad (max 6 credits)	
Select one of the following:		3
BIOL 2804	Ecology	
BIOL 4114	Global Change Ecology	
FIW 4624	Marine Ecology	
Subtotal		9-11
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement (Students may need to complete less credit hours in this category depending on choices in categories above)		8-9
Subtotal		8-9
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/ option requirements		

Pathways Concept 2 - Critical Thinking in the Humanities	
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)	6
Pathways Concept 3 - Reasoning in the Social Sciences	
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)	6
Pathways Concept 4 - Reasoning in the Natural Sciences	
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements	
Pathways Concept 5 - Quantitative and Computational Thinking	
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements	
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements	
Pathways Concept 6 - Critique and Practice in Design and the Arts	
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)	3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)	3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States	
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	27
Total Credits	**120-126**

[1] Credits may double-count for Major Requirements and Pathways.
[2] Credits may double-count for Option Requirements and Pathways.
[3] If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Satisfactory Progress Toward Degree (Policy 91)

1. By 45 hours attempted at Virginia Tech, students must have completed the following courses:
   - GEOS 2004 Geosciences Career and Professional Development
   - GEOS 2024 Earth's Dynamic Systems (or GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratoryand GEOS 1014 Evolution of the Earth-Life System)(or GEOS 2104 Elements of Geology, GEOS 1014 Evolution of the Earth-Life System)
   - GEOS 2444 Geoscience Field Observations
   - GEOS 3504 Mineralogy
   - MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable
   - CHEM 1035 General Chemistry
   - CHEM 1045 General Chemistry Laboratory
2. By 60 hours attempted at Virginia Tech, students must have completed the following courses:
   - PHYS 2205 General Physics and PHYS 2215 General Physics Laboratory or PHYS 2305 Foundations of Physics
3. Students must achieve an overall GPA of 2.0 and an in-major GPA of 2.5 upon attempting 15 GEOS credit hours (including transfer credit, courses completed with a grade of "W", advanced placement or IB credit)

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.5 or greater. The in-major GPA is calculated from all GEOS courses.

Prerequisites

Except when noted, all prerequisites are listed on the checksheet. There are no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Even when listed, prerequisites are subject to change. Please consult University Course Catalog for current information.

Acceptable Substitutions

- GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- GEOS 4974 Independent Study for GEOS 4994 Undergraduate Research
- CHEM 1055 General Chemistry for Chemistry Majors or CHEM 1055H for CHEM 1035 General Chemistry
- CHEM 1065 General Chemistry for Chemistry Majors Lab for CHEM 1045 General Chemistry Laboratory
- COMM 1015 Communication Skills for ENGL 1105 First-Year Writing
- COMM 1016 Communication Skills for ENGL 1106 First-Year Writing

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Geosciences Major with Geochemistry Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	3
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		21
Major Requirements		
GEOS 4024	Senior Seminar [1]	3

GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
MATH 1225	Calculus of a Single Variable [2]	4
MATH 1226	Calculus of a Single Variable [2]	4
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2305	Foundations of Physics [2]	4
PHYS 2306	Foundations of Physics [2]	4
CHEM 1036	General Chemistry [2]	3
CHEM 1046	General Chemistry Laboratory [2]	1
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CHEM 2424	Descriptive Inorganic Chemistry	3
or CHEM 2514	Survey of Organic Chemistry	
GEOS 3704	Igneous and Metamorphic Rocks	3
GEOS 4634	Environmental Geochemistry	3
Select six credits of the following:		6
GEOS 4964	Field Study	
GEOS 4994	Undergraduate Research	
Subtotal		42
Elective Courses		
Select 11 credit hours from list below. You can select from within themes or across themes.		11
Environmental Theme		
GEOS 3014	Environmental Geosciences	
GEOS/CSES/ GEOG 3304	Geomorphology	
GEOS 3614/ CSES 3114	Soils	
GEOS 3624/ CSES 3124	Soils Laboratory	
GEOS 4804	Groundwater Hydrology	
Energy, Mining and Materials Theme		
GEOS 4624	Mineral Deposits	
GEOS 4824	Engineering Geology	
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development	
MINE 2504	Introduction to Mining Engineering	
MSE 2034	Elements of Materials Engineering	
NANO 1015	Introduction to Nanoscience: From Atoms to Applications	
NANO 1016	Introduction to Nanoscience	
Chemistry Theme		
CHEM 2535	Organic Chemistry	
CHEM 2536	Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
CHEM 4615	Physical Chemistry for the Life Sciences	
CHEM 4616	Physical Chemistry for the Life Sciences	
Subtotal		11
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement		3
Subtotal		3
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		27
Total Credits		**120**

[1] Credits may double-count for Major Requirements and Pathways.
[2] Credits may double-count for Option Requirements and Pathways.
[3] If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	3
GEOS 3204	Sedimentology-Stratigraphy	3

GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		21
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
MATH 1225	Calculus of a Single Variable [2]	4
MATH 1226	Calculus of a Single Variable [2]	4
MATH 2204	Introduction to Multivariable Calculus	3
PHYS 2305	Foundations of Physics [2]	4
PHYS 2306	Foundations of Physics [2]	4
CHEM 1036	General Chemistry [2]	3
CHEM 1046	General Chemistry Laboratory [2]	1
CHEM 2114	Analytical Chemistry	3
CHEM 2124	Analytical Chemistry Laboratory Techniques and Practice	1
CHEM 2424	Descriptive Inorganic Chemistry	3
or CHEM 2514	Survey of Organic Chemistry	
GEOS 3704	Igneous and Metamorphic Rocks	3
GEOS 4634	Environmental Geochemistry	3
Select six credits of the following:		6
GEOS 4964	Field Study	
GEOS 4994	Undergraduate Research	
Subtotal		42
Elective Courses		
Select 11 credit hours from list below. You can select from within themes or across themes.		11
Environmental Theme		
GEOS 3014	Environmental Geosciences	
GEOS/CSES/ GEOG 3304	Geomorphology	
GEOS 3614/ CSES 3114	Soils	
GEOS 3624/ CSES 3124	Soils Laboratory	
GEOS 4804	Groundwater Hydrology	
Energy, Mining and Materials Theme		
GEOS 4624	Mineral Deposits	
GEOS 4824	Engineering Geology	
MINE 2114	Energy and Raw Materials: Geopolitics and Sustainable Development	
MINE 2504	Introduction to Mining Engineering	
MSE 2034	Elements of Materials Engineering	
NANO 1015	Introduction to Nanoscience: From Atoms to Applications	
NANO 1016	Introduction to Nanoscience	
Chemistry Theme		
CHEM 2535	Organic Chemistry	
CHEM 2536	Organic Chemistry	
CHEM 2545	Organic Chemistry Laboratory	
CHEM 2546	Organic Chemistry Laboratory	
CHEM 4615	Physical Chemistry for the Life Sciences	
CHEM 4616	Physical Chemistry for the Life Sciences	
Subtotal		11
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement		3
Subtotal		3
Pathways to General Education [3]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		27
Total Credits		**120**

1. Credits may double-count for Major Requirements and Pathways.
2. Credits may double-count for Option Requirements and Pathways.
3. If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Geosciences Major with Geology Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	3
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		21
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
Select one sequence of the following:		14-16
Sequence 1		
MATH 1025	Elementary Calculus [3]	
MATH 1026	Elementary Calculus [3]	
PHYS 2205 & PHYS 2215	General Physics and General Physics Laboratory [3]	
PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory [3]	
Sequence 2 (preferred)		
MATH 1225	Calculus of a Single Variable [3]	
MATH 1226	Calculus of a Single Variable [3]	
PHYS 2305	Foundations of Physics [3]	
PHYS 2306	Foundations of Physics [3]	
Subtotal		14-16
GEOS 3704	Igneous and Metamorphic Rocks	3
GEOS 3104	Elementary Geophysics	3
GEOS 4964	Field Study (approved field camp)	6
GEOS 4924	Tectonics	4
Subtotal		16
Option Elective Courses		
GEOS 3XXX-4XXX	Geosciences Elective [2,4]	17
Subtotal		17
Free Electives		
Complete remaining credit hours needed to satisfy degree 120 credit hour requirement (Students may need to complete less credit hours in this category depending on choices in categories above)		9
Subtotal		9
Pathways to General Education [5]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		27
Total Credits		**120-122**

1. Credits may double-count for Major Requirements and Pathways.
2. See University Course Catalog for prerequisites.
3. Credits may double-count for Option Requirements and Pathways.
4. Maximum of 3 credits of GEOS 4994 Undergraduate Research can be applied.
5. If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Satisfactory Progress Toward Degree (Policy 91)

1. By 45 hours attempted at Virginia Tech, students must have completed the following courses:
   - GEOS 2004 Geosciences Career and Professional Development
   - GEOS 2024 Earth's Dynamic Systems (or GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014

Evolution of the Earth-Life System) (or GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System)
- GEOS 2444 Geoscience Field Observations
- GEOS 3504 Mineralogy
- MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable
- CHEM 1035 General Chemistry
- CHEM 1045 General Chemistry Laboratory

2. By 60 hours attempted at Virginia Tech, students must have completed the following courses:
   - PHYS 2205 General Physics and PHYS 2215 General Physics Laboratory, or PHYS 2305 Foundations of Physics
3. Students must achieve an overall GPA of 2.0 and an in-major GPA of 2.5 upon attempting 15 GEOS credit hours (including transfer credit, courses completed with a grade of "W", advanced placement or IB credit)

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.5 or greater. The in-major GPA is calculated from all GEOS courses.

Prerequisites

Except when noted, all prerequisites are listed on the checksheet. There are no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Even when listed, prerequisites are subject to change. Please consult University Course Catalog for current information.

Acceptable Substitutions

- GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- GEOS 4974 Independent Study for GEOS 4994 Undergraduate Research
- CHEM 1055 General Chemistry for Chemistry Majors or CHEM 1055H for CHEM 1035 General Chemistry
- CHEM 1065 General Chemistry for Chemistry Majors Lab for CHEM 1045 General Chemistry Laboratory
- COMM 1015 Communication Skills for ENGL 1105 First-Year Writing
- COMM 1016 Communication Skills for ENGL 1106 First-Year Writing

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

1.

Geosciences Major with Geophysics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
GEOS 2004	Geosciences Career and Professional Development	3
GEOS 2024	Earth's Dynamic Systems	6
GEOS 2444	Geoscience Field Observations	3
GEOS 3204	Sedimentology-Stratigraphy	3
GEOS 3404	Elements of Structural Geology	3
GEOS 3504/ MSE 3104	Mineralogy	3
Subtotal		21
Major Requirements		
GEOS 4024	Senior Seminar [1]	3
GEOG 2084	Principles of Geographic Information Systems	3
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
STAT 3005	Statistical Methods [1]	3
or STAT 3615	Biological Statistics	
Select one of the following:		3
GEOS 3024	Computational Methods in the Geosciences	
CS 1044	Introduction to Programming in C	
CS 1064	Introduction to Programming in Python	
Subtotal		16
Option Required Courses		
MATH 1225	Calculus of a Single Variable [2]	4
MATH 1226	Calculus of a Single Variable [2]	4
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2214	Introduction to Differential Equations	3
MATH 2114	Introduction to Linear Algebra	3
PHYS 2305	Foundations of Physics [2]	4
PHYS 2306	Foundations of Physics [2]	4
GEOS 3104	Elementary Geophysics	3
Select three of the following:		11-12
GEOS 4154	Earthquake Seismology (odd years)	
GEOS 4164	Potential Field Methods in Exploration Geophysics (odd years)	
GEOS 4174	Exploration Seismology (even years)	
GEOS 4924	Tectonics	
Subtotal		39-40
Elective Courses		
GEOS 3XXX-4XXX [3]		11
MATH or PHYS 3XXX-4XXX with exception of PHYS 3254 and PHYS 4224 [3]		3
Subtotal		14
Free Electives		
Select 3-4 credits of free electives		3-4
Subtotal		3-4

Pathways to General Education [4]		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Pathways Concept 1 - Discourse (Advanced) completed by major/option requirements		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Pathways Concept 4 - Reasoning in the Natural Sciences completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking		
Pathways Concept 5 - Quantitative and Computational Thinking (Foundation) completed by major/option requirements		
Pathways Concept 5 - Quantitative and Computational Thinking (Advanced) completed by major/option requirements		
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		27
Total Credits		**120-122**

1. Credits may double-count for Major Requirements and Pathways.
2. Credits may double-count for Option Requirements and Pathways.
3. See University Course Catalog for prerequisites.
4. If requirements completed as outlined, **18 credit hours of Pathways will be satisfied** by major/option requirements. Pathways requirements and approved courses are available online: https://www.pathways.prov.vt.edu/

Satisfactory Progress Toward Degree (Policy 91)

1. By 45 hours attempted at Virginia Tech, students must have completed the following courses:
   - GEOS 2004 Geosciences Career and Professional Development
   - GEOS 2024 Earth's Dynamic Systems (or GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014 Evolution of the Earth-Life System)(or GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System)
   - GEOS 2444 Geoscience Field Observations
   - GEOS 3504 Mineralogy
   - MATH 1225 Calculus of a Single Variable
   - CHEM 1035 General Chemistry
   - CHEM 1045 General Chemistry Laboratory
2. By 60 hours attempted at Virginia Tech, students must have completed the following courses:
   - PHYS 2305 Foundations of Physics
3. Students must achieve an overall GPA of 2.0 and an in-major GPA of 2.5 upon attempting 15 GEOS credit hours (including transfer credit, courses completed with a grade of "W", advanced placement or IB credit)

Graduation Requirements

Graduation requires completion of a minimum of 120 credit hours with a GPA of 2.0 or greater for all hours attempted. In addition, students must have an in-major GPA of 2.5 or greater. The in-major GPA is calculated from all GEOS courses.

Prerequisites

Except when noted, all prerequisites are listed on the checksheet. There are no hidden prerequisites, although some of the courses listed are prerequisites for other courses. Even when listed, prerequisites are subject to change. Please consult University Course Catalog for current information.

Acceptable Substitutions

- GEOS 1004 Earth Science: Our Past, Present, and Future and GEOS 1104 Introduction to Earth Sciences Laboratory and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- GEOS 2104 Elements of Geology and GEOS 1014 Evolution of the Earth-Life System for GEOS 2024 Earth's Dynamic Systems
- CHEM 1055 General Chemistry for Chemistry Majors or CHEM 1055H for CHEM 1035 General Chemistry
- CHEM 1065 General Chemistry for Chemistry Majors Lab for CHEM 1045 General Chemistry Laboratory
- COMM 1015 Communication Skills for ENGL 1105 First-Year Writing
- COMM 1016 Communication Skills for ENGL 1106 First-Year Writing
- MATH 2114H Introduction to Linear Algebra for MATH 2114 Introduction to Linear Algebra
- MATH 2214H Introduction to Differential Equations for MATH 2214 Introduction to Differential Equations
- MATH 2204H Introduction to Multivariable Calculus for MATH 2204 Introduction to Multivariable Calculus

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

1.

Mathematics

Our Website (http://www.math.vt.edu)

Overview

Mathematics is essential to a clear and complete understanding of virtually all phenomena. Its precision, depth, and generality support the development of critical thinking and problem-solving skills. The study of mathematics provides the ability to describe applied problems quantitatively and to analyze these problems in a precise and logical manner. This is a principal reason behind the strong demand for mathematicians in government and industry. Essentially all complex problems, whether physical, social, or economic, are solved by designing a mathematical model, analyzing the model, and determining computational algorithms for an efficient and accurate approximation of a solution. Each of these phases is mathematical in nature. For example, if a problem deviates from a standard form, a mathematician should be able to adjust the usual mathematical treatment of the problem to accommodate the deviation. In this case mathematical training provides a practical preparation for a career in today's changing world. Moreover, it is especially valuable because it is an education that equips one to continue to adapt to new situations.

Mathematicians typically are employed as applied mathematicians in their specialty areas. Our recent mathematics graduates have been divided among government and industry, graduate school, and teaching. There are four different paths or degree options that a student may follow towards a B.S. in Mathematics:

1. the Traditional Option;
2. the Applied Computational Mathematics Option (ACM);
3. the Applied Discrete Mathematics Option (ADM); and
4. the Mathematics Education Option (MSTR).

The Traditional Option, as its name implies, yields a broad and flexible background in mathematics, while the other three options are more specialized. The ACM option is designed for students who want to have an applied mathematics career in an area closely associated with physics, some form of engineering, etc. The Traditional and ACM options require students to work with their advisor to create a plan of study for an Interdisciplinary Application of Mathematics. This plan consists of courses in an applied area of the student's choosing that will support their post-graduation goals. The ADM option is designed for students primarily interested in areas of applied mathematics closely associated with computer science. The Mathematics Education Option is designed for students who want to be certified to teach secondary mathematics.

The ADM Option is designed for students who want to have an applied mathematics career in an area closely associated with computer science. The Education Option is designed for students who want to teach high-school or middle-school mathematics. The ADM and Math Ed options have the Interdisciplinary Application of Mathematics and associated required courses already determined -- computer science courses for ADM and teaching-focused courses for Math Ed. More details and specific requirements can be found in the Program Curriculum of each degree option.

Though each of the degree options has different graduation requirements, and each is intended to support various post-graduation goals, all four degree options yield the same degree -- a B.S. in Mathematics. The first two years of coursework are nearly identical among the degree options, making it easy to change degree options early in your undergraduate mathematical career. It is critical that you discuss your mathematical interests and post-graduation goals with your advisor early and often in order to determine the degree option that will be best suited for you. If you are interested in graduate study, seek advice early and often about the degree option, coursework, and research experience(s) that provide the best preparation for graduate work in your mathematical area of interest.

Scholarships

In a typical year the Math Department awards more than $60,000 to 30+ students with the majority going to continuing students. Undergraduate students will be emailed with specific steps to follow in order to be considered for a Math Department awarded scholarship.

Mathematical Contests, Competitions, and Activities

The Mathematics Department firmly believes that mathematics is not only useful and beautiful, but also fun. The department sponsors student chapters of MAA (Mathematical Association of America), SIAM (Society for Industrial and Applied Mathematics), Pi Mu Epsilon (the national mathematics honorary society), and AWM (Association for Women in Mathematics). As well as social activities, these groups sponsor speakers to talk on how mathematics is used in their work. Each fall, Virginia Tech also sponsors the Virginia Tech Regional Mathematics Contest. In addition, students (not all of whom are mathematics majors) may receive organized preparation and compete in the nationwide William Lowell Putnam Competition and the international Mathematical Contest in Modeling. Matecharlas provides students with the opportunity for informal discussions about 1000-level MATH courses with instructors fluent in Spanish. More information about these student chapters and activities can be found on our undergraduate website in the section titled Opportunities for VT Math Students: math.vt.edu/undergrad-math (https://math.vt.edu/undergrad-math.html)

Undergraduate Research

The Mathematics Department at Virginia Tech emphasizes and features activity in undergraduate research. Numerous institutions, including the National Science Foundation, the American Mathematical Society, and the Society for Industrial & Applied Mathematics, also emphasize the importance of developing research opportunities for undergraduates. Undergraduate research experiences serve to prepare students for life after the B.S. degree, both in the industrial world and in graduate school.

There are several ways to participate in mathematics undergraduate research. Some students participate in projects with stipend support, some earn course credit as MATH 4994, and others participate purely for the experience. Undergraduate research projects are typically directed by faculty members. The Mathematics Department hosts a competition each spring, where undergraduates can present their research and the top presenter wins the Layman Prize. To find an undergrad research project to participate in, students are encouraged to reach out to any faculty member about potential research interests and/or to reach out to our faculty members who serve as the coordinators of our undergraduate research program. More information, including contact information for the Math Department Undergraduate Research Coordinators, research competitions and prizes, forms, and more can be found at: https://math.vt.edu/undergrad-math/undergraduate-research.html.

Honors Sections of Math Courses

Several academic departments in the College of Science, including the Mathematics Department, offer special Honors sections of their courses. More information is available at math.vt.edu/honors (http://www.math.vt.edu/honors/). In addition to special sections of some courses, the Honors Office sponsors a colloquia series each semester. The colloquia explore special topics not in the University

Curriculum. Details about the Honors College can be found at http://www.honorscollege.vt.edu.

Math Credit from College-Level Exams

Students can earn credit for math courses through college-level exams such as AP, IB, CLEP, Cambridge, etc. The most common credit earned through college-level exams is MATH 1225 Calculus of a Single Variable and possibly also MATH 1226 Calculus of a Single Variable. More information can be found at: https://www.registrar.vt.edu/Transferable-Credit.html

Senior Awards

In each of the four degree options, one student is selected each year as the Outstanding Senior. An overall Outstanding Senior is also selected. All awardees are recognized at an awards reception in the spring semester. The College of Science has awards for one Outstanding Senior and one Outstanding Researcher among all students in the college, and the Math Department puts forward a nominee for each of these awards.

Accelerated Undergraduate/Graduate Degree Program in Mathematics

The Accelerated Undergraduate/Graduate Degree Program is intended to allow undergraduate students who are prepared to take graduate courses to complete M.S. requirements one year after completing B.S. requirements.. The principal feature of the program is that it allows the students to use 12 credits of graduate work simultaneously toward the completion of their bachelor's degree and a program of study leading to a master's degree. It is this ability to complete the final year of undergraduate work with the same courses that comprise much of the first year of graduate work that makes it possible to finish both degrees in five years. For more information, students should contact the Math Department Graduate Program Director and consult: https://www.math.vt.edu/content/dam/math_vt_edu/documents/accel-u-g-degree.pdf

Students in the Math Education degree option may apply to an optional fifth year to earn an M.A.Ed. in Curriculum & Instruction with a specialization in Mathematics Education in the Virginia Tech School of Education. The 5-year program is designed to satisfy Virginia's licensure requirements for teaching mathematics in secondary schools.

The department also offers a Ph.D. program.

Advising and Resources

Math Department academic advisors are also faculty members who can discuss details of course and career advice throughout your undergraduate career, in addition to many other aspects of undergraduate educational life. Advising information and resources can be found at: math.vt.edu/advising (https://math.vt.edu/undergrad-math/advising.html).

In addition to your assigned academic advisor, the Mathematics Department has designated Career Advisors. The Career Advisors will work with your academic advisor to provide information that will aid you in planning a career-oriented program. Information about career opportunities and career fairs will be sent to students periodically. In addition, you can explore the career resources and information posted on the Math Department's Career Advising website: math.vt.edu/careers (http://www.math.vt.edu/careers/).

Further information on the Mathematics Program can be found at www.math.vt.edu (http://www.math.vt.edu).

Minor in Mathematics

Requirements

At least 26 credits comprised of: MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2114 Introduction to Linear Algebra, MATH 2214 Introduction to Differential Equations and 9 hours of approved mathematics courses numbered 3000 or higher. See Math Minor requirements for details, exceptions, and allowed substitutions. Students are required to have 2.0 in-minor GPA and all courses used for the math minor must be taken in A-F grade mode. To graduate with a Virginia Tech undergraduate degree, a minimum of 25% of total credits for majors and minors must be taken at Virginia Tech. This means at least 7 credits for the math minor must be taken at Virginia Tech.

- Mathematics Major (p. 1301)
- Mathematics Major with Applied and Discrete Mathematics Option (p. 1303)
- Mathematics Major with Applied Computational Mathematics Option (p. 1305)
- Mathematics Major with Mathematics Education (Master's Track) Option (p. 1307)

Chair: Sarah Reznikoff
Director for Undergraduate Programs: N. Loehr
Graduate Director: A. Norton
Class of 1950 Professor in Mathematics: S. Gugercin
John K. Costain Faculty Chair and Professor: T. Warburton
Hatcher Professor of Mathematics: J. A. Burns
Professors: S. Adjerid, D. Appelo, C. A. Beattie, J. Borggaard, Y. Cheng, S. Ciupe, E. de Sturler, A. Elgart, M. Embree, P. E. Haskell, T. L. Herdman, T. Iliescu, T. Lin, N. Loehr, G. Matthews, A. Miedlar, C. Mihalcea, , A. Norton, M. Shimozono, S. Sun, S. T. Warburton, M. Wawro, and P. Yue
Associate Professors: N. Abaid, L. Childs, H. Liu, D. Orr, E. Palsson, P. Wapperom, P. Yue, and L. Zietsman
Assistant Professors: G. Camliyurt, P. Cazeaux, A. Deuchert, D. Douglas, I. Fracas, E. Johnson, J. LeGrow, H. Leo, H. Lopez Valdez, J. Madrid Padilla, E. Martin, T. Morrison, M. Pasha, M. Robert, J. Rudi, A. Sarah, O. Saucedo, W. Sun, S. Werner, and Y. Yang
Collegiate Associate Professors: R. Arnold
Collegiate Assistant Professors: E. Ufferman and J. Wilson
Visiting Assistant Professors: G. Alam, A. Biswas, K. Flanagan, P. Manoharan, S. Pantic, K. Saglam, and R. Steiner, and T. Topcu
Patricia Ann Caldwell Post-Doctoral Fellow and Visiting Assistant Professor: I. Huq-Kuruvilla and R. Singh
Senior Instructors: D. Agud, T. A. Bourdon, J. Clemons, H. Hart, J. Hurdus, N. Robbins, and J. Schmale.
Advanced Instructors: S. Barreto, M. Chung, S. Hammer, E. Jasso Hernandez, K. Karcher, C. Letona, M. Ouliaei-Nia, S. Silber, J. Thompson, and K. Zachrich
Instructors: H. Abobaker, T. Asfaw, S. Aslan, T. Balkew, J. Burleson, D. Callie, R. Carracedo Rodriguez, P. Caruso, S. Cvitanov, F. Elsrrawi, J. England, J. Evans, H. Farhat, G. Fowler, N. Garcia Hilares, P. Jones, T. Juste, K. Kasebian, D. Kim, M. Mahmood, N. Malik, B. Nguyen, C. Nicolas, K. Perera, S. Pidaparthi, I. Quinlan, E. F. Rabby, K. Robinson, Rappold, G. Seebohm, R. Sharpe, J. St.Clair, J. Truman, D. Valvo, J. Wells, and C. Withrow
Presidential Postdoctoral Associate: E. Camps Moreno

Postdoctoral Associates: J. Antonides, E. Camps, K. Castellano, L. LeJeune, H. Jiuhua, P. Mlimarć, J. Reyes, W. Santos, P. Soto, P. Tsai, and F. Yan
Senior Research Associate: S. Meng
Lecturers: V. Kairamkonda, W. Reilly, A. Sibol, and E. Widdowson
Career Advisors: E. de Sturler and J. Wilson
Scholarship Chair: L. Childs

Undergraduate Course Descriptions (MATH)

MATH 1004 - Discovering Mathematics I (1 credit)
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics such as logic systems, recreational mathematics, LaTeX programming, history, ethics, open problems, and research in mathematics. Also includes advising topics such as planning a Virginia Tech course of study. P/F only. Math majors.
Instructional Contact Hours: (1 Lec, 1 Crd)

MATH 1014 - Precalculus with Transcendental Functions (3 credits)
Precalculus college algebra, basic functions (algebraic, exponential, logarithmic, and trigonometric), conic sections, graphing techniques, basic probability. Usage of mathematical models, analytical calculations, and graphical or numerical representations of data to analyze problems from multiple disciplines that address intercultural and global challenges in areas such as chemistry, environmental science, the life sciences, finance, and statistics. Use of spreadsheet software. Two units of high school algebra and one of plane geometry are required.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1025 - Elementary Calculus (3 credits)
Quantitative and computational thinking to address relevant global issues. Unified calculus course covering techniques and applications of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for the life sciences. 1025: Differential calculus, graphing, applications for the life sciences, use of spreadsheet software. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit of trigonometry and precalculus. 1026: Integral calculus, numerical techniques, elementary differential equations, applications for the life sciences, use of spreadsheet and scientific software. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1026 and 1226.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1026 - Elementary Calculus (3 credits)
Quantitative and computational thinking to address relevant global issues. Unified calculus course covering techniques and applications of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for the life sciences. 1025: Differential calculus, graphing, applications for the life sciences, use of spreadsheet software. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit of trigonometry and precalculus. 1026: Integral calculus, numerical techniques, elementary differential equations, applications for the life sciences, use of spreadsheet and scientific software. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1026 and 1226.
Prerequisite(s): MATH 1025 or MATH 1225
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1044 - Discovering Mathematics II (2 credits)
Introduction to the scope and applicability of mathematics and its many sub-disciplines. Introduction to the process of thinking, learning, and writing as a mathematician through topics in pure and applied mathematics and a brief experience with mathematical research. Also includes advising topics such as planning a Virginia Tech course of study. Math majors.
Instructional Contact Hours: (2 Lec, 2 Crd)

MATH 1214 - Preparation for Calculus (3 credits)
Linear equations, polynomials, relations and functions, rational functions, quadratic equations, radicals and functions with rational exponents, exponentials, logarithms, trigonometric functions, trigonometric identities. Designed as preparation for MATH 1225: Calculus of a Single Variable.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1225 - Calculus of a Single Variable (4 credits)
1225-1226: CALCULUS OF A SINGLE VARIABLE Quantitative and computational thinking to address relevant intercultural and global issues. Unified calculus course covering techniques of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for science and engineering. 1225: limits, continuity, differentiation, transcendental functions, applications of differentiation, introduction to integration. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and precalculus, and placement by Math Dept. 1226: techniques and applications of integration, trapezoidal and Simpson's rules, improper integrals, sequences and series, power series, parametric curves and polar coordinates, software-based techniques. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1525 and 1225. A student can earn credit for at most one of 1026 and 1226. Pre: Grade of at least C- in 1225 for 1226.
Prerequisite(s): MATH 1214
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1226 - Calculus of a Single Variable (4 credits)
1225-1226: CALCULUS OF A SINGLE VARIABLE Quantitative and computational thinking to address relevant intercultural and global issues. Unified calculus course covering techniques of differential and integral calculus for functions of one variable. Constitutes the standard first-year mathematics courses for science and engineering. 1225: limits, continuity, differentiation, transcendental functions, applications of differentiation, introduction to integration. Assumes 2 units of high school algebra, 1 unit of geometry, 1/2 unit each of trigonometry and precalculus, and placement by Math Dept. 1226: techniques and applications of integration, trapezoidal and Simpson's rules, improper integrals, sequences and series, power series, parametric curves and polar coordinates, software-based techniques. A student can earn credit for at most one of 1025 and 1225. A student can earn credit for at most one of 1525 and 1225. A student can earn credit for at most one of 1026 and 1226. Pre: Grade of at least C- in 1225 for 1226.
Prerequisite(s): MATH 1225
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1454 - Introduction to Programming for Mathematical Problem-Solving (3 credits)
Introduction to programming for mathematical problem solving. Programming software interfaces. Logic and conditional computations. Iterative computations and recursion. Data arrays. Compartmentalized computations using functions. Data visualization. Data input/output. Programming applications such as Monte Carlo simulation, random walks, computational geometry, and graph theory.
Corequisite(s): MATH 1225
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1524 - Business Calculus (4 credits)
Differential calculus techniques for functions of one and two variables. Emphasis on graphs, rates of change, and optimization of linear, quadratic, exponential, and logistic functions. Terminology and applications for business, including spreadsheet software. Mathematical models of real-world business problems, including discrete and continuous models, that address intercultural and global challenges in such areas as finance, marketing, and accounting. Assumes 2 units of high school algebra and 1 unit of geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (4 Lec, 4 Crd)

MATH 1535 - Geometry and Mathematics of Design (3 credits)
A standard first-year mathematics sequence for architecture majors. Mathematical models of real-world problems, including discrete and continuous models, that address relevant global challenges in such areas as urban planning, building construction, and home design. 1535: Euclidean geometry, trigonometry, sequences and the golden ratio, graph theory, tilings, polygons and polyhedra, applications for 2- and 3-dimensional design and construction, use of geometric software. 1536: vectors in the plane and space, descriptive and projective geometry, differential and integral calculus, applications for 2- and 3-dimensional design and construction, including areas, volumes, centroids, and optimization. Assumes 2 unites of high school algebra and 1 unit of high school geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1536 - Geometry and Mathematics of Design (3 credits)
A standard first-year mathematics sequence for architecture majors. Mathematical models of real-world problems, including discrete and continuous models, that address relevant global challenges in such areas as urban planning, building construction, and home design. 1535: Euclidean geometry, trigonometry, sequences and the golden ratio, graph theory, tilings, polygons and polyhedra, applications for 2- and 3-dimensional design and construction, use of geometric software. 1536: vectors in the plane and space, descriptive and projective geometry, differential and integral calculus, applications for 2- and 3-dimensional design and construction, including areas, volumes, centroids, and optimization. Assumes 2 unites of high school algebra and 1 unit of high school geometry.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1614 - Numbers and Operations for Teachers (3 credits)
Study of the nature and structure of numbers for prospective elementary and middle school teachers; number theory, number systems, operations and algebraic thinking, problem solving, and mathematical modeling. 1614 may not be taken by math majors for credit.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1624 - Geometry for Teachers (3 credits)
Study of key geometry concepts for prospective elementary and middle school teachers; multiple perspectives including transformational, coordinate, Euclidean and analytical geometry; geometric modeling; geometric and spatial reasoning. 1624 may not be taken by math majors for credit.
Prerequisite(s): MATH 1614
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2114 - Introduction to Linear Algebra (3 credits)
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases, orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114 and 2405H.
Prerequisite(s): MATH 1225 or MATH 1226 or
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2114H - Introduction to Linear Algebra (3 credits)
Vector and matrix algebra systems of linear equations, linear equations, linear independence, bases, orthonormal bases, rank, linear transformations, diagonalization, implementation with contemporary software. Math 1226 or a grade of at least B in VT MATH 1225. A student can earn credit for at most one of 2114H and 2405H.
Prerequisite(s): MATH 1225 or MATH 1226 or
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2204 - Introduction to Multivariable Calculus (3 credits)
Calculus for functions for several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204 and 2406H. A student can earn credit for at most one of 2024 and 2204. A student can earn credit for at most one of 2204 and CMDA 2005.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2204H - Introduction to Multivariable Calculus (3 credits)
Calculus for functions of several variables. Planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, software-based techniques. A student can earn credit for at most one of 2204H and 2406H. A student can earn credit for at most one of 2024 and 2204H. A student can earn credit for at most one of 2204H and CMDA 2005.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2214 - Introduction to Differential Equations (3 credits)
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214 and 2406H. A student can earn credit for at most one of 2214 and CMDA 2006.
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H or ISC 2105) and MATH 1226
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2214H - Introduction to Differential Equations (3 credits)
Unified course in ordinary differential equations. First-order equations, second-and-higher-order constant coefficient linear equations, systems of first-order linear equations, and numerical methods. Mathematical models describing motion and cooling, predator-prey population models, SIR-models, mechanical vibrations, electric circuits, rates of chemical reactions, radioactive decay. Quantitative and computational thinking to address relevant intercultural and global issues. A student can earn credit for at most one of 2214H and 2406H. A student can earn credit for at most one of 2214H and CMDA 2006
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H or ISC 2105) and MATH 1226
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2405H - Mathematics in a Computational Context (5 credits)
Unified course covering topics from linear algebra, differential equations, and calculus for functions of several variables. Comprises the standard second year mathematics courses for science and engineering. 2405H: Vector and matrix algebra, systems of linear equations, linear independence, bases, orthonormal bases, rank, linear transformations and diagonalization. Ordinary linear homogeneous differential equations, implementation with contemporary software. 2406H: Ordinary nonhomogeneous differential equations, calculus for functions of several variables, planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, with software-based techniques. A student can earn credit for at most one of 2114, 2114H, and 2405H. A student can earn credit for at most one of 2204, 2204H, and 2406H. A student can earn credit for at most one of 2214, 2214H, and 2406H.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (5 Lec, 5 Crd)

MATH 2406H - Mathematics in a Computational Context (5 credits)
Unified course covering topics from linear algebra, differential equations, and calculus for functions of several variables. Comprises the standard second year mathematics courses for science and engineering. 2405H: Vector and matrix algebra, systems of linear equations, linear independence, bases, orthonormal bases, rank, linear transformations and diagonalization. Ordinary linear homogeneous differential equations, implementation with contemporary software. 2406H: Ordinary nonhomogeneous differential equations, calculus for functions of several variables, planes and surfaces, continuity, differentiation, chain rule, extreme values, Lagrange multipliers, double and triple integrals and applications, with software-based techniques. A student can earn credit for at most one of 2114, 2114H, and 2405H. A student can earn credit for at most one of 2204, 2204H, and 2406H. A student can earn credit for at most one of 2214, 2214H, and 2406H.
Prerequisite(s): MATH 2405H
Instructional Contact Hours: (5 Lec, 5 Crd)

MATH 2534 - Introduction to Discrete Mathematics (3 credits)
Emphasis on topics relevant to computer science. Topics include logic, propositional calculus, set theory, relations, functions, mathematical induction, elementary number theory and Boolean algebra. Does not carry credit for mathematics majors, but may be used as though it were a 3000-level elective course for the mathematics minor. Two units of high school algebra, one unit of geometry, one-half unit each of trigonometry and precalculus mathematics required. 2534 may not be taken by math majors for credit without special permission. A student can earn credit for at most one of 2534 and 3034.
Prerequisite(s): CS 1114 or ECE 1574 or ECE 1004 or CS 2064
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 2644 - Mathematics Tutoring (1 credit)
Introduction to professional, culturally respectful mathematics tutoring. Development of listening and questioning skills, assessment of students' mathematical difficulties. Exploration of teaching and learning processes, effectively utilizing technology, and adjusting instruction to diversity in students' mathematical reasoning. Concurrent mathematics tutoring experience required. May be repeated twice with different leadership expectations for a maximum of 3 credits.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

MATH 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MATH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2984H - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 3034 - Introduction to Proofs (3 credits)
Practice in writing mathematical proofs. Exercises from set theory, number theory, and functions. Propositional logic, set operations, equivalence relations, methods of proof, mathematical induction, the division algorithm and images and pre-images of sets. A student can earn credit for at most one of 2534 and 3034.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 2405H
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3124 - Modern Algebra (3 credits)
Introduction to abstract algebraic structures (groups, rings, and fields) and structure-preserving maps (homomorphisms) for these structures. Proof-intensive course illustrating the rigorous development of a mathematical theory from initial axioms.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3134 - Applied Combinatorics and Graph Theory (3 credits)
Emphasis on concepts related to computational theory and formal languages. Includes topics in graph theory such as paths, circuits, and trees. Topics from combinatorics such as permutations, generating functions, and recurrence relations.
Prerequisite(s): MATH 1226 and (MATH 2534 or MATH 3034)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3144 - Linear Algebra I (3 credits)
Introductory course in linear algebra. Abstract vector spaces, linear transformations, algorithms for solving systems of linear equations, matrix analysis. This course involves mathematical proofs.
Prerequisite(s): (MATH 3034 or MATH 2534) and (MATH 2114 or MATH 2114H or MATH 2405H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3214 - Calculus of Several Variables (3 credits)
Fundamental calculus of functions of two or more variables. Implicit function theorem, Taylor expansion, line integrals, Greens theorem, surface integrals.
Prerequisite(s): MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3224 - Advanced Calculus (3 credits)
Theory of limits, continuity, differentiation, integration, series. 3224 duplicates 4525.
Prerequisite(s): (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 3414 - Numerical Methods (3 credits)
Computational methods for numerical solution of non-linear equations, differential equations, approximations, iterations, methods of least squares, and other topics. A grade of C or better required in CS prerequisite 1044 or 1705. A student can earn credit for at most one of 3414 and 4404.
Prerequisite(s): (CS 1044 or CS 1705 or CS 1114 or CS 1124) and MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CS 3414

MATH 3574 - Applied Complex Variables (1 credit)
Arithmetic of complex numbers. Geometry of the complex plane. Geometry of exponentiation and roots. Complex exponential, trigonometric and hyperbolic functions. Continuity and differentiability. Analytic and harmonic functions.
Prerequisite(s): MATH 2204 or MATH 2204H
Instructional Contact Hours: (1 Lec, 1 Crd)

MATH 4044 - History of Mathematics (3 credits)
Historical development of mathematics from antiquity to modern times. Senior standing in mathematics or mathematics education required.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4124 - Introduction to Abstract Algebra (3 credits)
An introduction to the theory of groups and rings. Topics include normal subgroups, permutation groups, Sylows Theorem, Abelian groups, Integral Domains, Ideals, and Polynomial Rings.
Prerequisite(s): MATH 3124
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4134 - Number Theory (3 credits)
Introduction to elementary number theory. Topics covered may include divisibility, greatest common divisors, unique prime factorization, congruences, Fermat's Little Theorem, Chinese Remainder Theorem, multiplicative number-theoretic functions, Diophantine equations, primitive roots, and the Quadratic Reciprocity Law.
Prerequisite(s): MATH 3034 or MATH 3134
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4144 - Linear Algebra II (3 credits)
Second course in linear algebra. Similarity invariants, Jordan canonical form, inner product spaces, self-adjoint operators, selected applications.
Prerequisite(s): MATH 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4175 - Cryptography (3 credits)
4175: Introduction to classical and modern symmetric-key cryptography; alphabetic ciphers, block ciphers and stream ciphers; background in modular arithmetic and probability; perfect secrecy; linear and differential cryptanalysis; Advanced Encryption Standard; hashing. 4176: Introduction to modern public-key cryptography and cryptanalysis; RSA algorithm, ElGamal algorithm, Diffie-Hellman algorithm; digital signatures; background in group theory and number theory; algorithms for primality testing, factoring, and discrete logarithms; elliptic curves.
Prerequisite(s): MATH 3034 or MATH 3124 or MATH 3134 or MATH 3144 or MATH 3224 or MATH 4134 or CMDA 3605
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4176 - Cryptography (3 credits)
4175: Introduction to classical and modern symmetric-key cryptography; alphabetic ciphers, block ciphers and stream ciphers; background in modular arithmetic and probability; perfect secrecy; linear and differential cryptanalysis; Advanced Encryption Standard; hashing. 4176: Introduction to modern public-key cryptography and cryptanalysis; RSA algorithm, ElGamal algorithm, Diffie-Hellman algorithm; digital signatures; background in group theory and number theory; algorithms for primality testing, factoring, and discrete logarithms; elliptic curves.
Prerequisite(s): MATH 4175 or CMDA 3606 or MATH 3034 or MATH 3134 or MATH 3144
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4225 - Elementary Real Analysis (3 credits)
Real number system, point set theory, limits, continuity, differentiation, integration, infinite series, sequences and series of functions.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4226 - Elementary Real Analysis (3 credits)
Real number system, point set theory, limits, continuity, differentiation, integration, infinite series, sequences and series of functions.
Prerequisite(s): MATH 4225
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4234 - Elementary Complex Analysis (3 credits)
Analytic functions, complex integration, series representation of analytic functions, residues, conformal mapping, applications
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4245 - Intermediate Differential Equations (3 credits)
Solution techniques, linear systems, the matrix exponential, existence theorems, stability, non-linear systems, eigenvalue problems.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4254 - Chaos and Dynamical Systems (3 credits)
Survey of basic concepts in chaotic dynamical systems. Includes material on bifurcation theory, conjugacy, stability, and symbolic dynamics.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4324 - Elementary Topology (3 credits)
Basic concepts of topological spaces, continuous functions, connected spaces, compact spaces, and metric spaces.
Prerequisite(s): MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4334 - College Geometry (3 credits)
Transformational approach to Euclidean geometry including an in-depth study of isometries and their application to symmetry, geometric constructions, congruence, coordinate geometry, and non-Euclidean geometries.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4404 - Applied Numerical Methods (3 credits)
Interpolation and approximation, numerical integration, solution of equations, matrices and eigenvalues, systems of equations, approximate solution of ordinary and partial differential equations. Applications to physical problems. A student can earn credit for at most one of 3414 and 4404.
Prerequisite(s): MATH 4564 and (ESM 2074 or AOE 2074)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AOE 4404

MATH 4414 - Issues in Scientific Computing (3 credits)
Theory and techniques of modern computational mathematics, computing environments, computational linear algebra, optimization, approximation, parameter identification, finite difference and finite element methods and symbolic computation. Project-oriented course; modeling and analysis of physical systems using state-of-the-art software and packaged subroutines.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006) and MATH 3214 and (CS 1114 or MATH 1454)
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)
Course Crosslist: CS 4414

MATH 4425 - Fourier Series and Partial Differential Equations (3 credits)
Separation of variables for heat, wave, and potential equations. Fourier expressions. Application to boundary value problems. Bessel functions. Integral transforms and problems on unbounded domains.
Prerequisite(s): MATH 2406H or CMDA 2006 or MATH 2214 or MATH 2214H and MATH 3224
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4426 - Fourier Series and Partial Differential Equations (3 credits)
Separation of variables for heat, wave, and potential equations. Fourier expressions. Application to boundary value problems. Bessel functions. Integral transforms and problems on unbounded domains.
Prerequisite(s): MATH 4425
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4445 - Introduction to Numerical Analysis (3 credits)
4445: Vector spaces and review of linear algebra, direct and iterative solutions of linear systems of equations, numerical solutions to the algebraic eigenvalue problem, solutions of general non-linear equations and systems of equations. 4446: Interpolation and approximation, numerical integration and differentiation, numerical solutions of ordinary differential equations. Computer programming skills required.
Prerequisite(s): MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4446 - Introduction to Numerical Analysis (3 credits)
4445: Vector spaces and review of linear algebra, direct and iterative solutions of linear systems of equations, numerical solutions to the algebraic eigenvalue problem, solutions of general non-linear equations and systems of equations. 4446: Interpolation and approximation, numerical integration and differentiation, numerical solutions of ordinary differential equations. Computer programming skills required.
Prerequisite(s): MATH 2406H or (CMDA 2005 and CMDA 2006) or (MATH 2214 or MATH 2214H) and (MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4454 - Applied Mathematical Modeling (3 credits)
Analysis of classical and modern applications of mathematics in the physical, biological and social sciences. Emphasis on problem formulating, modeling, solving, simulating, and analyzing results. Programming language required.
Prerequisite(s): MATH 3214
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4564 - Operational Methods for Engineers (3 credits)
Laplace transformations, Fourier series, partial differential equations and separation of variables, boundary value problems, and Sturm-Liouville theory.
Prerequisite(s): (MATH 2214 or MATH 2214H) or MATH 2406H or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4574 - Vector and Complex Analysis for Engineers (3 credits)
Vector Analysis: Greens theorem, potential theory, divergence, and Stokes theorem. Complex Analysis: Analyticity, complex integration, Taylor series, residues, conformal mapping, applications. 4574 may not be taken by math majors for credit.
Prerequisite(s): MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4625 - Mathematics for Secondary Teachers (3 credits)
Course activities will emphasize the curricular themes of problem solving, reasoning and proof, communication, connections, and representation. 4625: Topics in discrete mathematics and algebra from a secondary teaching perspective. 4626: Topics in trigonometry, geometry, measurement, statistics, and probability from a secondary teaching perspective.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4626 - Mathematics for Secondary Teachers (3 credits)
Course activities will emphasize the curricular themes of problem solving, reasoning and proof, communication, connections, and representation. 4625: Topics in discrete methematics and algebra from a secondary teaching perspective. 4626: Topics in trigonometry, geometry, measurement, statistics, and probability from a secondary teaching perspective.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4644 - Secondary School Mathematics With Technology (3 credits)
Use and impact of technology in secondary mathematics curriculum. Various technologies including graphing calculators, calculator based laboratory and probes (CBLs), computer algebra systems, spreadsheets, dynamic geometry software and the Internet will be used to explore secondary mathematical concepts from an advanced viewpoint.
Prerequisite(s): MATH 3034
Instructional Contact Hours: (3 Lec, 3 Crd)

MATH 4664 - Senior Math Education Seminar (2 credits)
A review of basic principles and problem-solving techniques in the eleven topics covered by the Praxis II (Mathematics Content Knowledge) examination. Passing the Praxis II examination prior to student teaching is a state requirement for all students seeking secondary licensure. Passing Praxis I required.
Prerequisite(s): MATH 3124
Instructional Contact Hours: (2 Lec, 2 Crd)

MATH 4754 - Internship (1-19 credits)
May be repeated for a maximum of 12 credits.
Instructional Contact Hours: Variable credit course
Repeatability: up to 12 credit hours

MATH 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

MATH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

MATH 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Mathematics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Linear Algebra, Proofs, Proof-Based Calculus		
MATH 2114	Introduction to Linear Algebra	3
MATH 3034	Introduction to Proofs	3
MATH 3144	Linear Algebra I	3
MATH 3224	Advanced Calculus	3
Multi-D Calculus		
Select two of the following:		6
MATH 2204	Introduction to Multivariable Calculus	
MATH 2214	Introduction to Differential Equations	
MATH 3214	Calculus of Several Variables	
Computer Programming		
Select one course from the **Table of Programming Courses** below		3
Subtotal		21
Major Requirements		
Remaining Multi-D Calculus [1]		
MATH 3214	Calculus of Several Variables	3
or MATH 2214	Introduction to Differential Equations	
or MATH 2204	Introduction to Multivariable Calculus	
Algebra		
MATH 3124	Modern Algebra	3
Subtotal		6
Restricted Electives		
4000-Level Math Sequence/Cluster		
MATH 4XXX & MATH 4XXX	Select a two-course sequence/cluster from the **Table of 4000-Level Math Sequence/Cluster Options** below	6
4000-Level Math Electives [2]		
MATH 4XXX & MATH 4XXX	Select six credits of 4000-level MATH **subject to restrictions** in the footnote below	6
Math-Related Courses [3]		
Create a 12-credit course plan. Must be approved by Math Traditional Option ("No Option") Chair.		12
Subtotal		24
Free Electives [4]		
Select credits sufficient to achieve the 120 credit graduation requirement		22
Subtotal		22
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		

Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits from BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) . The course selected in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) may double-count with one other Pathway Concept if the selected course is also in another Pathway Concept.		3
Subtotal		47
Total Credits		**120**

Table of Programming Courses

Code	Title	Credits
MATH 1454	Introduction to Programming for Mathematical Problem-Solving	
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering [5]	
ME 2004	Engineering Analysis Using Numerical Methods [5]	

Table of 4000-Level Math Sequence/Cluster Options

Code	Title	Credits
OPTION 1		**6**
Select two of the following:		
MATH 4124	Introduction to Abstract Algebra	
MATH 4134	Number Theory	
MATH 4144	Linear Algebra II	
MATH 4175	Cryptography	
MATH 4176	Cryptography	
MATH 5114	Specialized Topics in Algebra	
OPTION 2		**6**
Select two of the following:		
MATH 4445	Introduction to Numerical Analysis	
MATH 4446	Introduction to Numerical Analysis	
MATH 4414	Issues in Scientific Computing	
OPTION 3		**6**
MATH 4225	Elementary Real Analysis	
MATH 4226	Elementary Real Analysis	
or MATH 423	Elementary Complex Analysis	
OPTION 4		**6**
MATH 4245	Intermediate Differential Equations	
MATH 4254	Chaos and Dynamical Systems	
or MATH 4454	Applied Mathematical Modeling	
or MATH 4425	Fourier Series and Partial Differential Equations	
or MATH 4564	Operational Methods for Engineers	
OPTION 5		**6**
MATH 4425	Fourier Series and Partial Differential Equations	
MATH 4426	Fourier Series and Partial Differential Equations	
OPTION 6		**6**
MATH 5454	Graph Theory	
MATH 5464	Combinatorics	

Footnotes

[1] ***Remaining Multi-D Calculus:*** Course selected for Remaining Multi-D Calculus must be unused from Multi-D Calculus section of the Degree Core above. In other words:

- if MATH 3214 is not selected in the Degree Core, select MATH 3214
- if MATH 2214 is not selected in the Degree Core, select MATH 2214
- if MATH 2204 is not selected in the Degree Core, select MATH 2204

[2] ***4000-Level Math Electives:*** Select six credits of 4000-level MATH subject to the restrictions below:

- At most one of the following is allowed:
  - MATH 4044 History of Mathematics
  - MATH 4334 College Geometry
- If MATH 4425 Fourier Series and Partial Differential Equations is taken as part of a 4000-Level Math Sequence/Cluster, then MATH 4564 Operational Methods for Engineers is not allowed as a 4000-Level Math Elective.
- If MATH 4564 Operational Methods for Engineers is taken as part of a 4000-Level Math Sequence/Cluster, then MATH 4425 Fourier Series and Partial Differential Equations is not allowed as a 4000-Level Math Elective.
- If neither MATH 4425 Fourier Series and Partial Differential Equations nor MATH 4564 Operational Methods for Engineers is taken as part of a 4000-Level Math Sequence/Cluster, then at most one of the following is allowed as a 4000-Level Math Elective:
  - MATH 4425 Fourier Series and Partial Differential Equations
  - MATH 4564 Operational Methods for Engineers
- The following CANNOT be used:
  - MATH 4574 Vector and Complex Analysis for Engineers
  - MATH 4625 Mathematics for Secondary Teachers
  - MATH 4626 Mathematics for Secondary Teachers
  - MATH 4644 Secondary School Mathematics With Technology
  - MATH 4664 Senior Math Education Seminar
- Math Undergraduate Policy & Curriculum Committee approval required to use any of the following. Consult your advisor.

- MATH 4974 Independent Study
- MATH 4984 Special Study
- MATH 4994 Undergraduate Research

[3] ***Math-Related Courses:*** See Undergraduate Handbook for Mathematics Majors (https://math.vt.edu/content/dam/math_vt_edu/documents/MathMajorHandbook.pdf) for details.

[4] ***Free Electives:*** MATH 1004 Discovering Mathematics I (1 credit) and MATH 1044 Discovering Mathematics II (2 credits) are strongly recommended free electives for first-year math majors.

[5] ***Computer Programming:*** Courses marked with this footnote are restricted to students in major(s) outside of mathematics, and are generally taken by students who are majoring in math and another major.

Satisfactory Progress to Degree

Satisfactory progress toward the B.S. in Mathematics requires:

1. **Must Take Math:** Within the previous two semesters, the student must satisfy one of the following:
   a. earn a C- or better in at least one of MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. earn a C or better in MATH 2114 Introduction to Linear Algebra
   c. pass a MATH course at the 3000-level or higher that is used in the in-major GPA calculation
2. **In-Major GPA:** Upon having attempted 45 credits (including all types of transfer credit, credit by exam, and course withdrawal), students must have an in-major GPA of 2.0 or above.
3. **Two-Attempt Policy:** Students must earn the following grades within two attempts at the following courses, including attempts ending in course withdrawal:
   a. C- or better: MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. C or better: MATH 2114 Introduction to Linear Algebra

Graduation Requirements

Minimum Credits Required For Graduation

120 Credits

Minimum GPA Required For Graduation

Students are required to have a 2.0 overall GPA and a 2.0 in-major GPA for graduation. In-major GPA for this option is computed using all MATH courses *with the exception of* MATH 1014 Precalculus with Transcendental Functions, MATH 1025 Elementary Calculus, MATH 1026 Elementary Calculus, MATH 1214 Preparation for Calculus, MATH 1454 Introduction to Programming for Mathematical Problem-Solving, MATH 1524 Business Calculus, MATH 1535 Geometry and Mathematics of Design, MATH 1536 Geometry and Mathematics of Design, MATH 1614 Numbers and Operations for Teachers, MATH 1624 Geometry for Teachers, MATH 2534 Introduction to Discrete Mathematics, MATH 2644 Mathematics Tutoring, MATH 3574 Applied Complex Variables, MATH 3624 , MATH 4574 Vector and Complex Analysis for Engineers, MATH 4625 Mathematics for Secondary Teachers, MATH 4626 Mathematics for Secondary Teachers, MATH 4644 Secondary School Mathematics With Technology, and MATH 4664 Senior Math Education Seminar.

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Policy & Curriculum Committee and approved by the Chair.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
2. MATH 2405H Mathematics in a Computational Context **and** MATH 2406H Mathematics in a Computational Context (both courses must be taken) may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Mathematics Major with Applied and Discrete Mathematics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Linear Algebra, Proofs, Proof-Based Calculus		
MATH 2114	Introduction to Linear Algebra	3
MATH 3034	Introduction to Proofs	3
MATH 3144	Linear Algebra I	3
MATH 3224	Advanced Calculus	3
Multi-D Calculus		
Select two of the following:		6
MATH 2204	Introduction to Multivariable Calculus	
MATH 2214	Introduction to Differential Equations	
MATH 3214	Calculus of Several Variables	
Computer Programming [1]		
Select one course from the **Table of Programming Courses** below		3
Subtotal		21
Option Required Courses		
Remaining Multi-D Calculus [2]		
MATH 3214	Calculus of Several Variables	3
or MATH 2214	Introduction to Differential Equations	

or MATH 2204	Introduction to Multivariable Calculus	
Mathematics		
MATH 3124	Modern Algebra	3
MATH 3134	Applied Combinatorics and Graph Theory	3
Computer Science and Statistics		
CS 2114	Software Design and Data Structures (Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D))	3
CS 2505	Introduction to Computer Organization	3
CS 3114	Data Structures and Algorithms	3
CS 4104	Data and Algorithm Analysis	3
or CS 4114	Introduction to Formal Languages and Automata Theory	
or CS 4124	Theory of Computation	
STAT 4705	Probability and Statistics for Engineers	3
or STAT 4714	Probability and Statistics for Electrical Engineers	
or STAT 4105	Theoretical Statistics	
Subtotal		24
Restricted Electives		
4000-Level Applied Discrete Math		
Select two of the following:		6
MATH 4124	Introduction to Abstract Algebra (fall only)	
MATH 4134	Number Theory (spring only)	
MATH 4144	Linear Algebra II (spring only)	
MATH 4175	Cryptography	
MATH 4176	Cryptography	
MATH 5114	Specialized Topics in Algebra (spring only) [3]	
MATH 5454	Graph Theory (fall only) [3]	
MATH 5464	Combinatorics (spring only) [3]	
4000-Level Math Electives [4]		
MATH 4XXX & MATH 4XXX	Select six credits of 4000-level MATH **subject to restrictions** in the footnote below	6
Subtotal		12
Free Electives [5]		
Select credits sufficient to achieve the 120 credit graduation requirement		16
Subtotal		16
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits from BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
CS 2114	Software Design and Data Structures (6D)	3
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) . The course selected in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) may double-count with one other Pathway Concept if the selected course is also in another Pathway Concept.		3
Subtotal		47
Total Credits		**120**

Table of Programming Courses

Code	Title	Credits
MATH 1454	Introduction to Programming for Mathematical Problem-Solving	
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering [6]	
ME 2004	Engineering Analysis Using Numerical Methods [6]	

Footnotes

1 ***Computer Programming:*** ADM students should take CS 1114 Introduction to Software Design to satisfy the prerequisite for CS 2114 Software Design and Data Structures.

2 ***Remaining Multi-D Calculus:*** Course selected for Remaining Multi-D Calculus must be unused from Multi-D Calculus section of the Degree Core above. In other words:

- if MATH 3214 is not selected in the Degree Core, select MATH 3214
- if MATH 2214 is not selected in the Degree Core, select MATH 2214
- if MATH 2204 is not selected in the Degree Core, select MATH 2204

3 ***4000-Level Applied Discrete Math:*** Instructor permission is required for undergraduates to take graduate-level courses.

4 ***4000-Level Math Electives:*** Select six credits of 4000-level MATH subject to the restrictions below:

- Any of the 4000-Level Applied Discrete Math course options that were not selected among the six credits of 4000-Level Applied Discrete Math can be used.
- At most one of the following is allowed:
  - MATH 4044 History of Mathematics
  - MATH 4334 College Geometry

- At most one of the following is allowed:
  - MATH 4425 Fourier Series and Partial Differential Equations
  - MATH 4564 Operational Methods for Engineers
- The following CANNOT be used:
  - MATH 4574 Vector and Complex Analysis for Engineers
  - MATH 4625 Mathematics for Secondary Teachers
  - MATH 4626 Mathematics for Secondary Teachers
  - MATH 4644 Secondary School Mathematics With Technology
  - MATH 4664 Senior Math Education Seminar
- Math Undergraduate Policy & Curriculum Committee approval required to use any of the following. Consult your advisor.
  - MATH 4974 Independent Study
  - MATH 4984 Special Study
  - MATH 4994 Undergraduate Research

[5] ***Free Electives:*** MATH 1004 Discovering Mathematics I (1 credit) and MATH 1044 Discovering Mathematics II (2 credits) are strongly recommended free electives for first-year math majors.

[6] ***Computer Programming:*** Courses marked with this footnote are restricted to students in major(s) outside of mathematics, and are generally taken by students who are majoring in math and another major.

Satisfactory Progress to Degree

Satisfactory progress toward the B.S. in Mathematics requires:

1. **Must Take Math:** Within the previous two semesters, the student must satisfy one of the following:
   a. earn a C- or better in at least one of MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. earn a C or better in MATH 2114 Introduction to Linear Algebra
   c. pass a MATH course at the 3000-level or higher that is used in the in-major GPA calculation
2. **In-Major GPA:** Upon having attempted 45 credits (including all types of transfer credit, credit by exam, and course withdrawal), students must have an in-major GPA of 2.0 or above.
3. **Two-Attempt Policy:** Students must earn the following grades within two attempts at the following courses, including attempts ending in course withdrawal:
   a. C- or better: MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. C or better: MATH 2114 Introduction to Linear Algebra

Graduation Requirements

Minimum Credits Required For Graduation

120 Credits

Minimum GPA Required For Graduation

Students are required to have a 2.0 overall GPA and a 2.0 in-major GPA for graduation. In-major GPA for this option is computed using all MATH courses *with the exception of* MATH 1014 Precalculus with Transcendental Functions, MATH 1025 Elementary Calculus, MATH 1026 Elementary Calculus, MATH 1214 Preparation for Calculus, MATH 1454 Introduction to Programming for Mathematical Problem-Solving, MATH 1524 Business Calculus, MATH 1535 Geometry and Mathematics of Design, MATH 1536 Geometry and Mathematics of Design, MATH 1614 Numbers and Operations for Teachers, MATH 1624 Geometry for Teachers, MATH 2534 Introduction to Discrete Mathematics, MATH 2644 Mathematics Tutoring, MATH 3574 Applied Complex Variables, MATH 3624 , MATH 4574 Vector and Complex Analysis for Engineers, MATH 4625 Mathematics for Secondary Teachers, MATH 4626 Mathematics for Secondary Teachers, MATH 4644 Secondary School Mathematics With Technology, and MATH 4664 Senior Math Education Seminar.

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Chair.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
2. MATH 2405H Mathematics in a Computational Context and MATH 2406H Mathematics in a Computational Context (both courses must be taken) may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Mathematics Major with Applied Computational Mathematics Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Linear Algebra, Proofs, Proof-Based Calculus		
MATH 2114	Introduction to Linear Algebra	3
MATH 3034	Introduction to Proofs	3
MATH 3144	Linear Algebra I	3
MATH 3224	Advanced Calculus	3
Multi-D Calculus		
Select two of the following:		6
MATH 2204	Introduction to Multivariable Calculus	
MATH 2214	Introduction to Differential Equations	

MATH 3214	Calculus of Several Variables	
Computer Programming		
Select one course from the **Table of Programming Courses** below		3
Subtotal		21
Option Required Courses		
Remaining Multi-D Calculus [1]		
MATH 3214	Calculus of Several Variables	3
or MATH 2204	Introduction to Multivariable Calculus	
or MATH 2214	Introduction to Differential Equations	
Numerical Analysis, Mathematical Modeling, and Scientific Computing		
MATH 4425	Fourier Series and Partial Differential Equations	3
MATH 4426	Fourier Series and Partial Differential Equations	3
or CMDA 4604	Intermediate Topics in Mathematical Modeling	
MATH 4445	Introduction to Numerical Analysis	3
MATH 4446	Introduction to Numerical Analysis	3
MATH 4414	Issues in Scientific Computing [2]	3
or MATH 4454	Applied Mathematical Modeling	
Subtotal		18
Restricted Electives		
4000-Level Math Electives [3]		
MATH 4XXX & MATH 4XXX	Select six credits of 4000-level MATH numbered between 4044 and 4454 **subject to restrictions and exceptions** in the footnote below	6
Applied Area Courses [4]		
Create a 12-credit course plan. Must be approved by Math ACM Option Chair.		12
Subtotal		18
Free Electives [5]		
Select sufficient credits to achieve the 120 credit graduation requirement		16
Subtotal		16
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits from BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) . The course selected in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) may double-count with one other Pathway Concept if the selected course is also in another Pathway Concept.		3
Subtotal		47
Total Credits		**120**

Table of Programming Courses

Code	Title	Credits
MATH 1454	Introduction to Programming for Mathematical Problem-Solving	
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering [6]	
ME 2004	Engineering Analysis Using Numerical Methods [6]	

Footnotes

1 ***Remaining Multi-D Calculus:*** Course selected for Remaining Multi-D Calculus must be unused from Multi-D Calculus section of the Degree Core above. In other words:

- if MATH 3214 is not selected in the Degree Core, select MATH 3214
- if MATH 2214 is not selected in the Degree Core, select MATH 2214
- if MATH 2204 is not selected in the Degree Core, select MATH 2204

2 ***Numerical Analysis, Mathematical Modeling, and Scientific Computing:*** Check prerequisites for MATH 4414 and MATH 4454 carefully. MATH 4414 is usually taught in the fall while MATH 4454 is usually taught in the spring. Any programming course will suffice as the programming prerequisite for MATH 4454.

3 ***4000-Level Math Electives:*** Select six credits of 4000-level MATH numbered between 4044 and 4454 subject to the following restrictions and exceptions:

- MATH 3124 Modern Algebra can also be used to as a 4000-Level Math Elective
- At most one of the following is allowed:
  - MATH 4044 History of Mathematics
  - MATH 4334 College Geometry
- Math Undergraduate Policy & Curriculum Committee approval required to use any of the following. Consult your advisor.
  - MATH 4974 Independent Study
  - MATH 4984 Special Study
  - MATH 4994 Undergraduate Research

[4] ***Applied Area Courses:*** See Undergraduate Handbook for Mathematics Majors (https://math.vt.edu/content/dam/math_vt_edu/documents/MathMajorHandbook.pdf) for details.

[5] ***Free Electives:*** MATH 1004 Discovering Mathematics I (1 credit) and MATH 1044 Discovering Mathematics II (2 credits) are strongly recommended free electives for first-year math majors.

[6] ***Computer Programming:*** Courses marked with this footnote are restricted to students in major(s) outside of mathematics, and are generally taken by students who are majoring in math and another major.

Satisfactory Progress to Degree

Satisfactory progress toward the B.S. in Mathematics requires that:

1. **Must Take Math:** Within the previous two semesters, the student must satisfy one of the following:
   a. earn a C- or better in at least one of MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. earn a C or better in MATH 2114 Introduction to Linear Algebra
   c. pass a MATH course at the 3000-level or higher that is used in the in-major GPA calculation
2. **In-Major GPA:** Upon having attempted 45 credits (including all types of transfer credit, credit by exam, and course withdrawal), students must have an in-major GPA of 2.0 or above.
3. **Two-Attempt Policy:** Students must earn the following grades within two attempts at the following courses, including attempts ending in course withdrawal:
   a. C- or better: MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. C or better: MATH 2114 Introduction to Linear Algebra

Graduation Requirements

Minimum Credits Required for Graduation

120 Credits

Minimum GPA Required for Graduation

Students are required to have a 2.0 overall GPA and a 2.0 in-major GPA for graduation. In-major GPA for this option is computed using all MATH courses *with the exception of* MATH 1014 Precalculus with Transcendental Functions, MATH 1025 Elementary Calculus, MATH 1026 Elementary Calculus, MATH 1214 Preparation for Calculus, MATH 1454 Introduction to Programming for Mathematical Problem-Solving, MATH 1524 Business Calculus, MATH 1535 Geometry and Mathematics of Design, MATH 1536 Geometry and Mathematics of Design, MATH 1614 Numbers and Operations for Teachers, MATH 1624 Geometry for Teachers, MATH 2534 Introduction to Discrete Mathematics, MATH 2644 Mathematics Tutoring, MATH 3574 Applied Complex Variables, MATH 3624 , MATH 4574 Vector and Complex Analysis for Engineers, MATH 4625 Mathematics for Secondary Teachers, MATH 4626 Mathematics for Secondary Teachers, MATH 4644 Secondary School Mathematics With Technology, and MATH 4664 Senior Math Education Seminar.

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Policy & Curriculum Committee and approved by the Chair.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
2. MATH 2405H Mathematics in a Computational Context **and** MATH 2406H Mathematics in a Computational Context (both courses must be taken) may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Mathematics Major with Mathematics Education (Master's Track) Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Linear Algebra, Proofs, Proof-Based Calculus		
MATH 2114	Introduction to Linear Algebra	3
MATH 3034	Introduction to Proofs	3
MATH 3144	Linear Algebra I	3
MATH 3224	Advanced Calculus	3
Multi-D Calculus		
Select two of the following:		6
MATH 2204	Introduction to Multivariable Calculus	
MATH 2214	Introduction to Differential Equations	
MATH 3214	Calculus of Several Variables	
Computer Programming		
Select one course from the **Table of Programming Courses** below		3
Subtotal		21
Option Required Courses		
Mathematics		
MATH 2644	Mathematics Tutoring [1]	1
MATH 3124	Modern Algebra	3
MATH 4044	History of Mathematics	3
MATH 4334	College Geometry	3
MATH 4625	Mathematics for Secondary Teachers	3
MATH 4626	Mathematics for Secondary Teachers	3
Statistics		

STAT 3005	Statistical Methods (Recommended, Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
or STAT 3604	Statistics for Social Science	
Field Experience		
EDCI 2004	Exploring the Teaching Profession- Field Studies in Education	3
Education		
EDCI 5604	Assessment and Diagnosis for the Mathematics Classroom [2]	3
Select two of the following:		6
EDEP 5154	Psych Foundations for Teachers [2]	
EDCI 5104	Schooling in American Society [2]	
EDCI 5554	Educating Exceptional Learners Across the Lifespan [2]	
EDCI 5264	Comprehending Processes and Reading in the Content Areas [2]	
Subtotal		31
Restricted Elective		
3000 or 4000-Level Math Elective [3]		
MATH 3/4XXX	Select three credits of 3000 or 4000-level MATH **subject to restrictions** in the footnote below	3
Subtotal		3
Free Electives [4]		
Select credits sufficient to achieve the 120 credit graduation requirement		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits from BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
STAT 3005	Statistical Methods (5A , Recommended)	3
or STAT 3604	Statistics for Social Science	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		6
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) . The course selected in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07) may double-count with one other Pathway Concept if the selected course is also in another Pathway Concept.		3
Subtotal		47
Total Credits		**120**

Table of Programming Courses

Code	Title	Credits
MATH 1454	Introduction to Programming for Mathematical Problem-Solving	
CS 1044	Introduction to Programming in C	
CS 1054	Introduction to Programming in Java	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering [5]	
ME 2004	Engineering Analysis Using Numerical Methods [5]	

Footnotes

[1] MATH 2644 Mathematics Tutoring can be repeated for credit up to three times (for three total credits).

[2] ***Education:*** To enroll in 5000-level EDCI and EDEP courses, students must be in their senior year with a 3.0 or better GPA.

[3] ***3000 or 4000-Level Math Elective:*** Select three credits of 3000 or 4000-level MATH subject to the following restrictions:

- If MATH 2204 is not selected in the Degree Core, select MATH 2204
- If MATH 2214 is not selected in the Degree Core, select MATH 2214
- Otherwise, select any 3000-level or 4000-level MATH course that is not used to meet other course-specific degree requirements.
- Math Undergraduate Policy & Curriculum Committee approval required to use any of the following. Consult your advisor.
  - MATH 4974 Independent Study
  - MATH 4984 Special Study
  - MATH 4994 Undergraduate Research

[4] ***Free Electives:*** MATH 1004 Discovering Mathematics I (1 credit) and MATH 1044 Discovering Mathematics II (2 credits) are strongly recommended free electives for first-year math majors.

[5] ***Computer Programming:*** Courses marked with this footnote are restricted to students in major(s) outside of mathematics, and are generally taken by students who are majoring in math and another major.

Satisfactory Progress to Degree

Satisfactory progress toward the B.S. in Mathematics requires:

1. **Must Take Math:** Within the previous two semesters, the student must satisfy one of the following:
   a. earn a C- or better in at least one of MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable

Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs

b. earn a C or better in MATH 2114 Introduction to Linear Algebra
c. pass a MATH course at the 3000-level or higher that is used in the in-major GPA calculation

2. **In-Major GPA:** Upon having attempted 45 credits (including all types of transfer credit, credit by exam, and course withdrawal), students must have an in-major GPA of 2.0 or above.
3. **Two-Attempt Policy:** Students must earn the following grades within two attempts at the following courses, including attempts ending in course withdrawal:
   a. C- or better: MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2204 Introduction to Multivariable Calculus, MATH 2214 Introduction to Differential Equations, MATH 3034 Introduction to Proofs
   b. C or better: MATH 2114 Introduction to Linear Algebra

Graduation Requirements

Minimum Credits Required For Graduation

120 Credits

Minimum GPA Required For Graduation

Students are required to have a 2.0 overall GPA and a 2.0 in-major GPA for graduation. In-major GPA for this option is computed using all MATH courses *with the exception of* MATH 1014 Precalculus with Transcendental Functions, MATH 1025 Elementary Calculus, MATH 1026 Elementary Calculus, MATH 1214 Preparation for Calculus, MATH 1454 Introduction to Programming for Mathematical Problem-Solving, MATH 1524 Business Calculus, MATH 1535 Geometry and Mathematics of Design, MATH 1536 Geometry and Mathematics of Design, MATH 1614 Numbers and Operations for Teachers, MATH 1624 Geometry for Teachers, MATH 2534 Introduction to Discrete Mathematics, MATH 2644 Mathematics Tutoring, MATH 3574 Applied Complex Variables, MATH 3624 , and MATH 4574 Vector and Complex Analysis for Engineers.

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Chair.

Acceptable Substitutions

1. MATH 2405H Mathematics in a Computational Context may be substituted for MATH 2114 Introduction to Linear Algebra.
2. MATH 2405H Mathematics in a Computational Context **and** MATH 2406H Mathematics in a Computational Context (both courses must be taken) may be substituted for MATH 2114 Introduction to Linear Algebra and MATH 2204 Introduction to Multivariable Calculus and MATH 2214 Introduction to Differential Equations.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credit hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Nanoscience

Our Website (https://www.ais.science.vt.edu/academics/Nanoscience.html)

Overview

The Nanoscience (NANO) program is a joint effort of the departments of Biological Sciences, Chemistry, Geosciences, and Physics. It resides in, and is organized as a division of, the College of Science's Academy of Integrated Science.

Nanoscience, the fundamental study of materials and structures whose size is on the nanometer scale, lies at the very foundation of our world. A nanometer is simply a billionth of a meter, and a typical atom is about 1/10th of a nanometer in size. At this length scale, atoms and molecules follow the laws of quantum physics, and the processes of life (for example, DNA and proteins are naturally-occurring nanoscale materials) and the properties of materials emerge from them. Due to a combination of profound theoretical insights, advances in scientific instrumentation, and massive computing power, we are now capable of imaging and steering single atoms with unprecedented precision, opening a window toward a world in which materials, chemical compounds, devices, and even small organisms can be built atom by atom and molecule by molecule, tailored toward desired properties and applications. At present, we are only at the dawn of this nanoscience revolution.

Nanoscience courses prepare undergraduates for productive, exciting careers in emerging nanoscale industries. Degree recipients from this program will be ready to contribute to and lead cutting-edge corporate research and development in some of the most important and profitable industries in the world, including information technology, communications, drug development, imaging, and environmental technology.

Bachelor of Science in Nanoscience

Nanoscience Majors

- Nanoscience B.S. Nanoscience (NANO)
- Nanoscience B.S. Nanoscience (NMED)

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "Academic Policies (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Nanoscience can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Minor in Nanoscience

Please visit the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html for requirements toward a minor in Nanoscience.

- Nanomedicine Major (p. 1311)
- Nanoscience Major (p. 1313)

Division Leader: F. M. Michel
Program Manager: C. Conley
Principle Faculty: D. Capelluto, H. Dorn, S. Emori, A. Esker, C. Finkielstein, R. Heflin, M. Hull, G. Khodaparast, G. Liu, B. Magill, J. Matson, A. Morris, V. Nguyen, K. Park, H. Robinson, and C. Tian

Undergraduate Course Descriptions (NANO)

NANO 1015 - Introduction to Nanoscience (3 credits)
Introduction to the interdisciplinary field of nanoscience with perspectives from biology, geoscience, computational science, chemistry, and physics. 1015: Historical perspectives; public perception; economic impact, nanoscience in biology and environment; quantum physics principles; characterization tools; mathematical modeling. 1016: Nanofabrication methods; nanoparticle synthesis and characterization; self-assembly; applications in medicine, electronics, and energy; sustainability. Pre: 1015 for 1016
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 1016 - Introduction to Nanoscience (3 credits)
Introduction to the intersdisciplinary field of nanoscience with perspectives from biology, geoscience, computational sceince, chemistry, and physics. 1015: Historical perspectives; public perception; economic impact, nanoscience in biology and environment; quantum physics principles; characterization tools; mathematical modeling. 1016: Nanofabrication methods; nanoparticle synthesis and characterization; self-assembly; applications in medicine, electronics, and energy; sustainability. Pre: 1015 for 1016.
Prerequisite(s): NANO 1015
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 2024 - Quantum Physics of Nanostructures (4 credits)
Introduction to the quantum physics which governs the properties of matter at the nanoscale. Specific topics include: Quantization, wave-particle duality, and Schrodinger equation, with applications to the hydrogen atom, periodic crystals, and nanostructures; electron spin, spintronics, and quantum statistical physics.
Prerequisite(s): NANO 1016 and MATH 1226 and (PHYS 2306 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 2114 - Nanoscience Research Seminar (1 credit)
Readings and discussion of current research areas of nanoscience and nanotechnology including nanofabrication, scanning probe techniques, functional nanomaterials, molecular engineering, bionanotechnology and nanomedicine. Presentations by guest nanoscience faculty on their research activities.
Prerequisite(s): NANO 1016
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 2324 - Quantum Physics for Nanomedicine (3 credits)
Introduction to quantum physics with a focus on nanomedicine related topics. Principles of quantization, wave-particle duality, Pauli exclusion principle, and the Schrödinger equation, with applications to the hydrogen atom, regular crystals, and nanostructures. Implications for nanomedicine of quantum dots, surface plasmon resonance, nanoscale sensing, and targeted drug delivery using nanoparticles.
Prerequisite(s): NANO 1016 and (PHYS 2206 or PHYS 2306 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 2814 - NanoCareers (1 credit)
Exploration of career opportunities in nanoscience and nanomedicine, including employment, graduate education, and health professions. Professional development activities, including resume assembly, career fairs, mentorship and networking, elevator pitch, entrepreneurship, and financial literacy. Pre: Sophomore standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 3015 - Nanoscale Synthesis, Fabrication, and Characterization (4 credits)
Tools for synthesis, fabrication and characterization of nanomaterials and nanostructures including organic and polymer synthesis, self-assembly, and top-down fabrication as well as methods for identifying their structure and electronic, optical, and thermal properties. 3015: Multiphase macromolecules; electron and scanning probe microscopies; fullerenes, graphene, and nanotubes; optical and electron spectroscopies, thermal analysis; quantum dots and metallic nanoparticles. 3016: Nucleic acid self-assembly; polyelectrolyte complexes; dynamic light scattering and zeta potential; electrostatic self-assembly; self-assembled monolayers; photolithography; electron and ion beam lithography; microcontact printing and nanoimprint lithography.
Prerequisite(s): CHEM 2514 or CHEM 2535 or CHEM 2565
Corequisite(s): 2024 or 2324 or PHYS 3324.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 3016 - Nanoscale Synthesis, Fabrication, and Characterization (4 credits)
Tools for synthesis, fabrication and characterization of nanomaterials and nanostructures including organic and polymer synthesis, self-assembly, and top-down fabrication as well as methods for identifying their structure and electronic, optical, and thermal properties. 3015: Multiphase macromolecules; electron and scanning probe microscopies; fullerenes, graphene, and nanotubes; optical and electron spectroscopies, thermal analysis; quantum dots and metallic nanoparticles. 3016: Nucleic acid self-assembly; polyelectrolyte complexes; dynamic light scattering and zeta potential; electrostatic self-assembly; self-assembled monolayers; photolithography; electron and ion beam lithography; microcontact printing and nanoimprint lithography.
Prerequisite(s): NANO 3015 and (CHEM 2514 or CHEM 2536 or CHEM 2566)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 3114 - Professional Dissemination of Nanoscience Research (1 credit)
Technical skills for dissemination of nanoscience research. Effective use of the nanoscience and nanotechnology literature, use of technologies that support collaborative oral and written communication. Key elements of effective journal publications and conference presentations.
Prerequisite(s): NANO 2114
Instructional Contact Hours: (1 Lec, 1 Crd)

NANO 3124 - Nanoscience and the Environment (3 credits)
Introduction to the connections between nanoscience, nanotechnology, and the environment. Overview of environmental science, why environmental issues are relevant to industry/business/research, naturally-occurring nanomaterials and their roles on Earth, and what is currently known about how manufactured and incidental nanomaterials interact with the atmosphere, hydrosphere, pedosphere, and biosphere.
Prerequisite(s): NANO 1016 and (BIOL 2124 or BIOL 2134 or NEUR 3044) and (CHEM 1036 or CHEM 1056 or ISC 2106H)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4124 - Advanced Nanomaterials and Devices (3 credits)
Overview of types of nanomaterials such as nanoparticles, quantum dots, fullerenes, carbon nanotubes, nanowires, graphene, and ultra-thin films. Special nanocomposite materials. Electronic, optical, magnetic, and transport properties of nanomaterials. Interactions between nanomaterials and substrates or interfaces. Applications of nanomaterials for electronics, magnetic storage, and energy-efficient devices.
Prerequisite(s): NANO 3016 and MATH 2214 and (NANO 2024 or PHYS 3324)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4314 - Nanomedicine (4 credits)
Medical use of nanomaterials including basic, translational, and clinical research. Nanomedical approaches to drug delivery. Diagnostic sensors. Use of nanomedical tools over conventional techniques to treat diseases/disorders. Technical issues associated with medical applications. Bioavailability of nanotherapies. Use of quantum dots for imaging. Ethical concerns and economic benefits associated with nanomedicine.
Prerequisite(s): NANO 3016 and (BIOL 2104 or BIOL 2124)
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

NANO 4324 - Introduction to Nanomedicine (3 credits)
Overview of fundamental biocompatible technologies under development at the nanoscale level and their application in the biomedical field.
Use of various forms and compositions of nanomaterials for potential applications in diagnosis, delivery, imaging, and treatment of human diseases. Focus on synthesis, characterization, and specific applications of nanomaterial as well as on nanotheranostics. Pharmacokinetic distribution of drug-embedded nanocarriers and their pharmacodynamics in biological systems. Nanoscale properties of materials for medical imaging. Classification of nanobiosensors used in clinical settings.
Prerequisite(s): NANO 3015 and (BIOL 2124 or BIOL 2134 or NEUR 3044)
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4334 - Advanced Nanomedicine (3 credits)
Medical use of nanomaterials in translational medicine and clinical research. Nanomedical approaches to targeted delivery and local imaging. Diagnostic sensors. Use of nanomedical tools over conventional techniques to diagnose and treat human diseases/disorders. Bioavailability and biocompatibility of nanotherapeutics. Ethical concerns and economic benefits associated with developing and implementing nanomedical approaches in the clinic. Use of nanotechnological advances for surgical procedures. Use of nanoparticles composites for nanodentistry and in nanodermatology. Safety protocols for the use of nanotechnology in clinical treatment.
Prerequisite(s): NANO 4324
Instructional Contact Hours: (3 Lec, 3 Crd)

NANO 4354 - Advanced Nanomedicine Laboratory (1 credit)
Use of nanotechnology to study cellular and molecular processes relevant to human diseases. Manipulation of nucleic acids. Use of various nanoparticle materials to study nucleic acids uptake by cells. Use of fluorescence and confocal imaging to identify homotypic and heterotypic cellular interactions. Purification of cells from biological fluids. Concepts in dielectrophoresis and microfluidic devices. Students must be certified to work with blood-borne pathogens from the Environmental Health and Safety department.
Prerequisite(s): NANO 4324
Corequisite(s): NANO 4334
Instructional Contact Hours: (3 Lab, 1 Crd)

NANO 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NANO 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Nanomedicine Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
NANO 1015	Introduction to Nanoscience: From Atoms to Applications [2]	
NANO 2114	Nanoscience Research Seminar [2,3]	
NANO 3015	Nanoscale Synthesis, Fabrication, and Characterization [2,3]	
NANO 3114	Professional Dissemination of Nanoscience Research [2,3]	
NANO 4324	Introduction to Nanomedicine [2,3]	
NANO 1016	Introduction to Nanoscience [2,3]	
NANO 2024	Quantum Physics of Nanostructures [2,3]	
NANO 3016	Nanoscale Synthesis, Fabrication, and Characterization [2,3]	
NANO 3124	Nanoscience and the Environment [2]	
NANO 4994	Undergraduate Research [2,4]	
Subtotal		34
Major Requirements		
BIOL 1105	Principles of Biology [2]	
BIOL 1106	Principles of Biology [2]	
BIOL 1115	Principles of Biology Laboratory [2]	
BIOL 1116	Principles of Biology Laboratory [2]	
BIOL 2134	Cell Function and Differentiation	
CHEM 1035	General Chemistry [2,3]	
CHEM 1036	General Chemistry [2]	
CHEM 1045	General Chemistry Laboratory [2,3]	
CHEM 1046	General Chemistry Laboratory [2]	
CHEM 2535	Organic Chemistry [3]	
CHEM 2545	Organic Chemistry Laboratory [3]	

CHEM 2536	Organic Chemistry [3]	
CHEM 2546	Organic Chemistry Laboratory	
NANO 2814	NanoCareers [2]	
Subtotal		28
Restricted Electives		0
Select three of the following: [4]		9
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BCHM 4116	General Biochemistry [2]	
BCHM 4784	Applications in Molecular Life Science [2]	
BIOL 2004	Genetics [2]	
BIOL 2604	General Microbiology [2]	
BIOL 3134	Human Genetics [2]	
BIOL 3404	Introductory Animal Physiology [2]	
BIOL 3774	Molecular Biology [2]	
BIOL 4664	Virology [2]	
BIOL 4674	Pathogenic Bacteriology [2]	
BIOL 4704	Immunology [2]	
BIOL 4734	Inflammation Biology [2]	
BIOL 4874	Cancer Biology [2]	
BIOL 4884	Cell Biology [2]	
BMSP 2135	Human Anatomy & Physiology [2]	
BMSP 2136	Human Anatomy and Physiology [2]	
CHEM/SBIO 4424	Polysaccharide Chemistry [2]	
CHEM 4444	Bioinorganic Chemistry [2]	
CHEM 4514	Green Chemistry [2]	
CHEM 4554	Drug Chemistry [2]	
FST 4504	Food Chemistry [2]	
NEUR 2025	Introduction to Neuroscience [2]	
NEUR 2026	Introduction to Neuroscience [2]	
NEUR 2554	Experimental Neuroscience [2]	
NEUR 3084	Cognitive Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
PHS 4064	Modeling Infectious Diseases [2]	
PSYC 2064	Introduction to Neuroscience of Behavior [2]	
SYSB 2024	Fundamentals of Systems Biology [1,2]	
SYSB 2034	Mathematical Methods in Systems Biology [1,2]	
SYSB 3035	Genomics and Bioinformatics [2]	
SYSB 3036	Genomics and Bioinformatics [2]	
SYSB 3115	Network Dynamics and Cell Physiology [2]	
SYSB 3116	Network Dynamics and Cell Physiology [2]	
Subtotal		9
Free Electives		
Select two credit hours		2
Subtotal		2

Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credit hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2205	General Physics [2]	3
PHYS 2206	General Physics [2]	3
PHYS 2215	General Physics Laboratory [2]	1
PHYS 2216	General Physics Laboratory [2]	1
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [2]	3
MATH 1026	Elementary Calculus (5F) [2]	3
Select three hours in Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 ***Fall/Spring Course Offerings:*** Please consult with your advisor to ensure the courses are offered in the semester you intend to take them.

2 ***In Major GPA:*** Courses will be used for computing the "in major" GPA.

3 **Prerequisites:** Some courses on this checksheet have pre-/co-requisites. Students are required to double check course pre-/co-requisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.

4 ***Undergraduate Research:*** All 8 credits are not taken in one semester. They are often split among different semesters

Upon having attempted 72 credit hours, the student will have completed -NANO 1015 Introduction to Nanoscience: From Atoms to Applications **AND** NANO 1016 Introduction to Nanoscience **AND** MATH 1025 Elementary Calculus **AND** MATH 1026 Elementary Calculus **AND** CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry **AND** CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory **AND** PHYS 2205 General Physics **AND** PHYS 2206 General Physics **AND** PHYS 2215 General Physics Laboratory **AND** PHYS 2216 General Physics Laboratory **AND** BIOL 1105 Principles of Biology **AND** BIOL 1106 Principles of Biology **AND** BIOL 1115 Principles of Biology Laboratory **AND** BIOL 1116 Principles of Biology Laboratory

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major. To graduate, a student must have at least a 2.0 in major GPA and overall GPA.

Acceptable Substitutions

- BCHM 3114 Biochemistry for Biotechnology and the Life Sciences may be substituted by taking BCHM 4115 General Biochemistry
- BIOL 2134 Cell Function and Differentiation may be substituted by taking NEUR 3044 Cellular and Molecular Neuroscience
- SYSB 3035 Genomics and Bioinformatics may be substituted by taking BIOL 4824 Bioinformatics Methods
- CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry may be substituted by taking CHEM 1055 General Chemistry for Chemistry Majors **AND** CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory may be substituted by taking CHEM 1065 General Chemistry for Chemistry Majors Lab **AND** CHEM 1066 General Chemistry for Chemistry Majors Lab
- CHEM 2535 Organic Chemistry **AND** CHEM 2536 Organic Chemistry may be substituted by taking CHEM 2565 Principles of Organic Chemistry **AND** CHEM 2566 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory **AND** CHEM 2546 Organic Chemistry Laboratory may be substituted by taking CHEM 2555 Organic Synthesis and Techniques Lab **AND** CHEM 2556 Organic Synthesis and Techniques Lab
- MATH 1025 Elementary Calculus **AND** MATH 1026 Elementary Calculus may be substituted by taking MATH 1225 Calculus of a Single Variable **AND** MATH 1226 Calculus of a Single Variable
- NANO 2024 Quantum Physics of Nanostructures may be substituted by taking PHYS 3324 Modern Physics **OR** NANO 2324 Quantum Physics for Nanomedicine
- NANO 3016 Nanoscale Synthesis, Fabrication, and Characterization may be substituted by taking NANO 4334 Advanced Nanomedicine **AND** NANO 4354 Advanced Nanomedicine Laboratory
- NEUR 3044 Cellular and Molecular Neuroscience may be substituted for BIOL 2134 Cell Function and Differentiation.
- PHYS 2205 General Physics **AND** PHYS 2215 General Physics Laboratory may be substituted by taking PHYS 2305 Foundations of Physics
- PHYS 2206 General Physics **AND** PHYS 2216 General Physics Laboratory may be substituted by taking PHYS 2306 Foundations of Physics
- BIOL 1105 Principles of Biology **AND** BIOL 1115 Principles of Biology Laboratory **AND** BIOL 1116 Principles of Biology Laboratory **AND** CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry **AND** CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory **AND** MATH 1025 Elementary Calculus **AND** MATH 1026 Elementary Calculus **AND** PHYS 2205 General Physics **AND** PHYS 2206 General Physics **AND** PHYS 2215 General Physics Laboratory **AND** PHYS 2216 General Physics Laboratory may be substituted by taking ISC 1105 Integrated Science I **AND** ISC 1106 Integrated Science I **AND** ISC 1115 Integrated Science Laboratory I **AND** ISC 1116 Integrated Science Laboratory I **AND** ISC 2105 Integrated Science II **AND** ISC 2106 Integrated Science II **AND** ISC 2115 Integrated Science Laboratory II **AND** ISC 2116 Integrated Science Laboratory II

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Nanoscience Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
NANO 1015	Introduction to Nanoscience: From Atoms to Applications [2]	3
NANO 2114	Nanoscience Research Seminar [2, 3]	1
NANO 3015	Nanoscale Synthesis, Fabrication, and Characterization [2, 3]	4
NANO 3114	Professional Dissemination of Nanoscience Research [2,3]	1
NANO 4324	Introduction to Nanomedicine [2,3]	3
NANO 1016	Introduction to Nanoscience [2,3]	3
NANO 2024	Quantum Physics of Nanostructures [2,3]	4
NANO 3016	Nanoscale Synthesis, Fabrication, and Characterization [2,3]	4
NANO 3124	Nanoscience and the Environment [2,3]	3
NANO 4994	Undergraduate Research [2,4]	8
Subtotal		34
Major Requirements		
CHEM 1035	General Chemistry [2,3]	3
CHEM 1045	General Chemistry Laboratory [2,3]	1
CHEM 2535	Organic Chemistry [3]	3
CHEM 2545	Organic Chemistry Laboratory [3]	1
MATH 2114	Introduction to Linear Algebra	3
CHEM 1036	General Chemistry [2,3]	3
CHEM 1046	General Chemistry Laboratory [2,3]	1
CHEM 2536	Organic Chemistry [3]	3
CHEM 2546	Organic Chemistry Laboratory [3]	1
BIOL 1105	Principles of Biology	3
NANO 4124	Advanced Nanomaterials and Devices [2,3]	3
NANO 2814	NanoCareers [2]	1
Subtotal		26
Free Electives		
Select 11 credit hours		11
Subtotal		11
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credit hours in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6

Select three credit hours in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credit hours in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credit hours in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2305	Foundations of Physics [2,3]	4
PHYS 2306	Foundations of Physics [2,3]	4
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [2,3]	4
MATH 1226	Calculus of a Single Variable (5F) [2,3]	4
MATH 2214	Introduction to Differential Equations (5A) [3]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credit hours in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credit hours in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credit hours in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. **Fall/Spring Course Offerings:** Please consult with your advisor to ensure the courses are offered in the semester you intend to take them.
2. **In Major GPA:** Courses will be used for computing the "in major" GPA.
3. **Prerequisites:** Some courses on this checksheet have pre-/co-requisites. Students are required to double check course pre-/co-requisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.
4. **Undergraduate Research:** All 8 credits are not taken in one semester. They are often split among different semesters.

Upon having attempted 72 credit hours, the student will have completed

- NANO 1015 Introduction to Nanoscience: From Atoms to Applications **AND** NANO 1016 Introduction to Nanoscience
- MATH 1225 Calculus of a Single Variable **AND** MATH 1226 Calculus of a Single Variable
- CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry,
- CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory
- PHYS 2305 Foundations of Physics **AND** PHYS 2306 Foundations of Physics

Graduation Requirements

120 graduation hours are required for graduation. These credits must include the courses required for the major (see above sections). To graduate, a student must have at least a 2.0 in major GPA and overall GPA.

Acceptable Substitutions

- BIOL 1105 Principles of Biology may be substituted by taking BIOL 2134 Cell Function and Differentiation **OR** NEUR 3044 Cellular and Molecular Neuroscience
- CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry may be substituted by taking CHEM 1055 General Chemistry for Chemistry Majors **AND** CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory may be substituted by CHEM 1065 General Chemistry for Chemistry Majors Lab **AND** CHEM 1066 General Chemistry for Chemistry Majors Lab
- NANO 2024 Quantum Physics of Nanostructures may be substituted by taking PHYS 3324 Modern Physics **OR** NANO 2324 Quantum Physics for Nanomedicine
- MATH 2114 Introduction to Linear Algebra may be substituted by taking MATH 2114H Introduction to Linear Algebra
- CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry **AND** CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory **AND** PHYS 2305 Foundations of Physics **AND** PHYS 2306 Foundations of Physics may be substituted by taking ISC 1005 Integrated Scientific Reasoning **AND** ISC 1006 Integrated Scientific Reasoning **AND** ISC 1115 Integrated Science Laboratory I **AND** ISC 1116 Integrated Science Laboratory I **AND** ISC 2115 Integrated Science Laboratory II **AND** ISC 2116 Integrated Science Laboratory II

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Neuroscience

Our Website (http://www.neuroscience.vt.edu)

Overview

Embark on a journey into the brain with the Neuroscience undergraduate program at Virginia Tech. This program, designed for ambitious students, offers dynamic majors: Clinical Neuroscience, Cognitive and Behavioral Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Whether you aspire to become a physician, researcher, or industry innovator, our curriculum ensures you are prepared. Many of our students follow a pre-med track, gaining a robust foundation that paves the way for medical school and beyond. With a comprehensive education that spans the fundamentals of brain functioning, research, healthcare, and numerous other fields, you'll be equipped to tackle the complexities of the human brain and nervous system.

Our interdisciplinary approach integrates knowledge from biology, psychology, computer science, and more, fostering a holistic understanding of neuroscience. As part of our Computational Neuroscience major, you'll also delve into artificial intelligence, gaining skills to leverage AI in understanding neural processes and developing

innovative solutions. Beyond academics, we emphasize professional development, ensuring you acquire essential problem-solving and critical thinking skills. With global perspectives and study abroad opportunities, you'll be prepared to apply your knowledge in diverse, real-world contexts. Join us to synthesize and apply knowledge in innovative ways, preparing you for a future where you can make a significant impact in your chosen field.

Neuroscience Majors

- Neuroscience B.S. Clinical Neuroscience (CNEU)
- Neuroscience B.S. Cognitive and Behavioral Neuroscience (CBNU)
- Neuroscience B.S. Computational and Systems Neuroscience (CSNU)
- Neuroscience B.S. Experimental Neuroscience (EXPN)

Transfer students should contact the department early, preferably one full semester prior to entrance. This procedure will allow a thorough evaluation of transfer credits and correct placement.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward Pathway to General Education (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Neuroscience can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Clinical Neuroscience Major (p. 1319)
- Cognitive and Behavioral Neuroscience Major (p. 1321)
- Computational and Systems Neuroscience Major (p. 1324)
- Experimental Neuroscience Major (p. 1326)

Director: M. Olsen
Professor: M. Olsen, M. Cline, E. Gilbert
Associate Professor: S. Clinton, K. Phillips, S. Vijayan, A. Pickrell, L. Ni, M. Weston, T. Jarome, K. Sewall
Assistant Professor: S. Agrawal, M. Buczynski, D. English, A. Gregus, M. Howe, G. Hodes, S. Macias, C. Thompson, J. Rainville, A. Shah, W. Legon, J. Basso, M. van der Heijden
Affiliated Faculty: L. Apfel, S. Ball, M. A. Bell, L. Bergamasco, A.S. Bertke, D. Bevan, W. Bickel, R. Blieszner, G. Cao, P. Carlier, A. Cate, J. Chappell, P. Chiu, , B. Corl, B. Costa, R. Davalos, S. DeLuca, M. Denbow, N. Dervisis, R. Diana, A.G. DiFeliceantonio, H. Dorn, , S. Farris, X. Feng, C. Finkielstein, C. Frank, J. Fraser, M. Friedlander, B. Friedman, D. Good, R. Gourdie, D. Harrison, G. Howes, R. Jensen, X. Jia, B. Johnson, J. Jones, B. S. Jortner, D. Kelly, B. King-Casas, B. Klein, S. Kojima, S. Laconte, Y. W. Lee, L. Li, C. Logan, E. Marvin,, T. Milam, R. Montague, I. Moore, A. Morozov, K. Mukherjee, N. Nanthakumar, M. Orr, R. Panneton, B. Patel, J. Phillips, J. Prickett, S. Ramey, K. Roberto, C. Rogers, J. Rossmeisl Jr., W. Santos, A. Scarpa, Z. Sheng, G. Simonds, D. J. Slade, A. Smith, M. Theus, P. VandeVord, S. Verbridge, E. Weaver, M. Witcher, C. Wyatt, D. Xie, B. Xu, and D. Zallen
Instructors: Z. Fu, D. McDaniel, and K. Unroe
Undergraduate Advisors: C. Cook, H. Tucker, and E. Vedder

Undergraduate Course Descriptions (NEUR)

NEUR 1004 - Neuroscience Orientation Seminar (2 credits)
Introduction to the field of neuroscience. Exposure to areas of practice and research, opportunities for education and training, and employment in the field. Academic and career planning for neuroscience majors. Discussion of university resources to promote student success.
Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2014H - Honors Fundamentals of Neuroscience (3 credits)
Fundamental concepts in neuroscience including nervous system organization, signaling within neurons and across synapses, sensory and motor systems, emotion, memory, and language. Major neurological disorders and animal models used in neuroscience. Restricted to non-neuroscience majors in the Honors College.
Prerequisite(s): BIOL 1105
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2025 - Introduction to Neuroscience (3 credits)
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.
Prerequisite(s): BIOL 1005 or BIOL 1105 or ISC 1106H
Corequisite(s): NEUR 2035
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2026 - Introduction to Neuroscience (3 credits)
Introduction to the fundamental principles of neuroscience. 2025: Structure and function of the nervous system. Cellular and molecular basis of neuronal signaling including electrical properties of neurons, synaptic transmission, and integration. Neurotransmitter systems and molecular signaling. Neural development and synaptic plasticity. 2026: Systems-level overview of the central nervous system. Sensory systems including olfaction, temperature, and pain. Retinal control of vision. Vestibular system and hearing. Motor systems and control of movement. Circuits related to stress, learning and behavior.
Prerequisite(s): NEUR 2025
Corequisite(s): NEUR 2036
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2035 - Neuroscience Laboratory (1 credit)
Organization and function of the nervous system. 2035: neuroanatomy, microscopy, intracellular stimulation, extracellular recording, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.
Corequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2036 - Neuroscience Laboratory (1 credit)
Organization and function of the nervous system. 2035: neuranatomy, microscopy, intercellular stimulation, extraceullular recording, nerve stimulation, electrophysiology, neurotransmitters, and neuroplasticity. 2036: receptive field, sensation and perception, motor system, simple neural circuitry, neuroendocrine and higher level cognitive processes.
Prerequisite(s): NEUR 2035
Corequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lab, 1 Crd)

NEUR 2364 - Mind Altering Substances from Nature (3 credits)
Neurobiological effects of psychoactive chemicals from nature. Neurotoxic effects and dangers of psychoactive plants and fungi. Therapeutic applications of mind-altering substances in neurological disease. Experimental uses of mind-altering chemicals in neuroscience research. Cultural history, legal standing, regulatory oversight, and contemporary use portrayals of mind-altering substances from nature in medicine and society. Neurobiological effects of psychoactive plant chemicals.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2464 - Neuroscience and Society (3 credits)
Social, ethical, and legal issues faced by human societies from the perspective of neuroscience. Broader questions about how neuroscience informs education, medicine, law, and public health. Research in neuroscience as it relates to issues of mental health, poverty, stress, and politics.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2554 - Experimental Neuroscience (3 credits)
Introduction to the conceptual framework of contemporary experimental methods and practices in neuroscience research. Exploration of experimental techniques including electrophysiology, advanced imaging, immunohistochemistry, transgenic animal models, and behavioral assays. Includes face-to-face interaction with various research faculty to explore research methods in practice and discuss current research and expertise.
Prerequisite(s): NEUR 2025 and NEUR 2035
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2594 - Exploring Clinical Neuroscience (3 credits)
Exploration of careers in clinical neuroscience. Introduction to neuroanatomy, clinical presentation of neurological diseases, application of neuroscientific research to clinical practice, and clinical treatments. Ethical challenges in clinical practice. Burnout and resilience.
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 3034 - Global Perspectives Pre-Departure (2 credits)
Preparation for Global Perspectives in Neuroscience and Medicine summer study abroad program. Travel preparations and financial planning. Academic overview and preparation. Risk management and travel etiquette. Introduction to global perspectives of neurological diseases. Restricted to students accepted into Global Perspectives in Neuroscience and Medicine summer study abroad program.
Instructional Contact Hours: (2 Lec, 2 Crd)

NEUR 3044 - Cellular and Molecular Neuroscience (3 credits)
Fundamental principles of cellular and molecular neuroscience. Methods to study neurochemisty and neurobiology, theoretical and practical issues of relating cellular/molecular structures and functions to higher-level nervous system functioning, and current understanding of cellular/molecular bases of nervous system disorders.
Prerequisite(s): NEUR 2025 and (CHEM 1036 or ISC 2105)
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3054 - Brain-Body Interactions in Health and Disease (3 credits)
Role of brain-body interactions in influencing an organism's health. Biological mechanisms involved in bidirectional communication between the brain, endocrine system, immune system, and digestive system. Gut microbiome and gut-brain axis in health and disease. Disease states linked to disturbed communication between brain and body, including diabetes, depression, autism, and Alzheimer's disease.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3074 - Evolutionary Neuroscience (3 credits)
Role of evolution and natural selection in shaping genetic, molecular, and cellular components of brain within invertebrates and vertebrates through modern humans. Evolution of molecules and cells in the brain. Comparing brain structure and function between invertebrates and vertebrates, including evolution of animal and human cognition and behavior. Adaptations of brain structure and function necessary for human cognition, emotion, language, and intelligence.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3084 - Cognitive Neuroscience (3 credits)
Concepts in cognitive neuroscience. Methods available to study brain and nervous system function, theoretical and practical issues of relating mental functions to biological brain functions. Overview of current understanding of the neural bases of various mental functions (e.g., memory, attention, emotion, decision making).
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3144 - Mechanisms of Learning and Memory (3 credits)
Foundation of social interactions in human and non-human: ability to learn and memorize locations, situations, individuals, facts and tasks forms. Cellular and molecular mechanism underlying learning and memory and model systems. Approaches to these processes along with diseases presenting with learning and memory deficits in humans.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3234 - The Artificial Brain (3 credits)
Introduction to brain-machine interactions and computer models of neural systems. Exploration of brain-computer interface applications, biophysically-based computational models of the brain, and computer neural networks in the context of artificial intelligence. Emphasis on the capabilities and limitations of neural networks and how they inform our understanding of the human brain. Discussion of societal impact and ethical considerations.
Prerequisite(s): NEUR 2026 and (MATH 1026 or MATH 1226)
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3554 - Neuroscience Research and Practical Experience (3 credits)
Integration of the interdisciplinary fields of neuroscience: includes the conceptual frameworks and theories of neuroscience spanning molecules to behavior, the methods available to study nervous system structure and function from molecules to behavior, theoretical and practical issues of linking these lower-levels structures and processes to higher-level neurological and psychological functions, and the latest applications and technologies for translating neuroscience into more effective interventions and treatments. Practical experience includes literature review research and writing, data analysis and interpretation, written and oral presentation, and site-specific training.
Prerequisite(s): NEUR 2026 and NEUR 2554
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3594 - Neurobiology of Psychiatric Disorders (3 credits)
Neurobiological and clinical aspects of psychiatry. Overview of disorders such as depression, anxiety, schizophrenia, addiction, and obsessive-compulsive disorder. Neurobiology of emotional behavior. Clinical perspectives of psychiatric treatment, interventional psychiatry, and cross-disciplinary approaches to psychiatry. Underlying pathophysiology of a variety of psychiatric disorders. Neuropharmacology of commonly used psychiatric medications. Ethical issues related to psychiatric care.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3604 - Neurobiochemistry (3 credits)
The biochemical mechanisms of the nervous system, with a focus on the human brain. Bioenergetics and nutrient metabolism in the central nervous system. Synthesis, function, and metabolism of neurotransmitters and neuropeptides, membrane chemistry, structure and function of neurotransmitter receptors and transporters, ion channels and pumps, secretory pathway and intracellular signaling pathways. The biochemistry of neuroactive drugs and toxins.
Prerequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3774 - Neuroendocrinology (3 credits)
Comprehensive survey of the interrelationships between human neural and endocrine systems. Regulatory mechanisms for neural control of hormone secretions, peripheral hormone action on physiological processes, and hormonal influences on behavior.
Prerequisite(s): NEUR 2025
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3844 - Computational Neuroscience and Neural Engineering (3 credits)
Introduction to computational and systems neuroscience. Data analysis and signal processing techniques for neural data. Neural modeling to include mean field models, Hodgkin-Huxley models, integrate and fire models. Neural engineering and brain machine interface (BMI) applications.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 3844

NEUR 3900 - Bridge Experience (0 credits)
Application of academic knowledge and skills to in a work-based experience aligned with post-graduation goals using research-based learning processes. Satisfactory completion of work-based experience often in the form of internship, undergraduate research, co-op, or study abroad; self-evaluation; reflection; and showcase of learning. Pre: Departmental approval of 3900 plan.
Instructional Contact Hours: (0 Crd)

NEUR 3914 - Neuroscience of Drug Addiction (3 credits)
History of addiction as a chronic, relapsing brain disease. Neurocircuitry and molecular basis of the brain affected by common drugs of abuse. Overview of the use, abuse, liability, and psychotherapeutic effects of drugs on humans. Common classes of drug abuse: alcohol, sedatives, tobacco/ nicotine, opiods, cannabinoids, psychostimulants, psychedelics, steroids, anti-anxiety, antidepressants, and antipsychotics. Animal models in drug addiction studies. Current and future pharmacotherapeutics for drug addiction treatment and ethical considerations of treatments.
Prerequisite(s): NEUR 2025 and NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3944 - War and the Brain (3 credits)
Neurological and psychological factors associated with military and war. Neuroscientific basis of decision making, mental resilience, and cognitive enhancement. Etiology and treatment of brain injuries sustained during war including post-traumatic stress disorder, traumatic brain injury, and chemical warfare. Neurotechnological advances that shape soldiers and warfare. Ethical considerations of militarization of neuroscience.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4034 - Diseases of the Nervous System (3 credits)
Common brain and Central Nervous System (CNS) disorders ranging from trauma to autism. Genetic, molecules and cellular changes in disease. Therapeutic implications and development of novel drugs. Challenges in drug discovery and implementation of personalized medicine. Ethical issues regarding genetic findings.
Prerequisite(s): NEUR 2026 and NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4044 - Neuroscience Senior Seminar (3 credits)
Integration of methods and results from cutting-edge interdisciplinary neuroscience research; theoretical and practical issues when linking molecular/cellular structures and processes to higher-level neurological and psychological functions. May be repeated twice with different content for a maximum of 9 credits.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 9 credit hours

NEUR 4054 - Developmental Neuroscience (3 credits)
Genetic, molecular, and cellular processes underlying brain development and neural circuit formation, including neural induction, cell differentiation, cell fate determination, axon guidance, neuronal migration, synapse formation, and cell death. Neurodevelopment processes in vertebrate and invertebrate animal models. Molecular and cellular underpinnings of neurodevelopmental disorders.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4064 - Neuropharmacology (3 credits)
Role of drugs affecting function of the brain, spinal cord, and peripheral nerves. Principles of pharmacology and biological mechanisms involved in pharmacokinetics (drug absorption, distribution, metabolism, elimination, and toxicity). Neurotransmission in peripheral and central nervous systems. Major classes of drugs affecting the nervous system (antidepressants, anxiolytics, antipsychotics, anticonvulsants, sedatives/hypnotics, analgesics, general and local anesthetics) and their mechanisms of action. Evaluate scientific findings of drug pharmacodynamics for major drug classes used to treat diseases of the nervous system.
Prerequisite(s): NEUR 2026
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4244 - Neural Control of Movement (3 credits)
Neuroscience of motor control and related disorders. How the neural system sub-components involved in motor control mediate motor reflexes, motor learning, central pattern generation, and motor control of speech and language. Sensorimotor physiology, proprioceptive system, exercise physiology. Neuro-rehabilitative technology and disruption of motor control by injury or disease.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4314 - Genetics in Neuroscience (3 credits)
Concepts of classical, modern genetics and epigenetics as it relates to neuroscience. Practical applications including genome-wide association (GWAS), next-generation sequencing, epigenetics, genome editing and screening methods. Use of model organisms in neurogenetic disorders research. Relationship of genetics and its influences on theoretical and practical issues in neurological and neurodevelopmental disorders. Personalized medicine in neurodevelopmental and neurogenetic disorders.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4364 - Neuroscience of Language and Communication Disorders (3 credits)
Concepts of language as distinctive human behavior and central to social life. Neural underpinnings of humans ability to speak and understand language. Neurologic processing of language comprehension and production in healthy and language-impaired individuals. Auditory and visual word recognition, reading, understanding speech, representation of word meaning, language production, and bilingualism. Neuroethology of communication and neurological disorders of communication: dyslexia, stuttering, and aphasia. Theoretical issues in language processing and converging evidence from different techniques and animal models addressing these issues.
Prerequisite(s): NEUR 3044 or NEUR 3084
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics in economics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4454, PSYC 4454

NEUR 4514 - Neuroimmunology in Health and Disease (3 credits)
Immune system and its role in neurological health and psychiatric and neurological disorders. Details of cell type, functions and signaling of the peripheral and central immune system and sympathetic nervous system. Cross-talk between the brain and immune system across the blood brain barrier and circumventricular organs. Neurobiological basis and treatment options for autoimmune diseases. Role of immune system in psychiatric illness.
Prerequisite(s): NEUR 3044
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4594 - Clinical Neuroscience in Practice (3 credits)
Clinical approaches to diagnose and treat neurological disorders. Diseases include stroke, trauma, brain tumors, psychiatric illnesses, and epilepsy. Clinical experience includes diagnostic procedures, radiological techniques, and surgical procedures in operating room. Patient rounding, follow-up, and outcomes. Medical emergencies and appropriate professional responses. Ethical issues regarding health care, disparity, life and death decisions. Medical profession exploration.
Prerequisite(s): NEUR 4034
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4814 - Nutritional Neuroscience (3 credits)
Concepts in nutritional aspects of neuroscience. Energy metabolism in central nervous system and brain regulating ingestive behavior. Communication with peripheral organs, regulation of whole body energy homeostasis, brain physiology and pathology on molecular and cellular level. Role of appetite neurocircuitry in formulation of practical solutions to societal problems such as nutrition, eating disorders, and obesity.
Prerequisite(s): NEUR 2026 or ALS 2304
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ALS 4814

NEUR 4914 - Drug Development in Neuroscience (3 credits)
Current approaches and pitfalls for developing therapeutics for treating disorders of the central nervous system (CNS). Theoretical issues and practical applications targeting identification, high-throughput screening, pharmacokinetics and pharmacodynamics, preclinical testing, clinical trials, and the FDA approval process. Ethical implications for drug development and testing.
Prerequisite(s): NEUR 3044 or NEUR 3914
Instructional Contact Hours: (3 Lec, 3 Crd)

NEUR 4964 - Field Work (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

NEUR 4994 - Undergraduate Research (1-19 credits)
$30 fee
Instructional Contact Hours: Variable credit course

NEUR 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Clinical Neuroscience Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
NEUR 1004	Neuroscience Orientation Seminar [1]	2
NEUR 2025	Introduction to Neuroscience [1,2]	3
NEUR 2026	Introduction to Neuroscience [1,2]	3
NEUR 2035	Neuroscience Laboratory [1]	1
NEUR 2036	Neuroscience Laboratory [1]	1
NEUR 4044	Neuroscience Senior Seminar [1,2]	3
PSYC 1004	Introductory Psychology [1,3]	3
Subtotal		22
Major Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
CHEM 2535	Organic Chemistry [2]	3
CHEM 2536	Organic Chemistry [2]	3
CHEM 2545	Organic Chemistry Laboratory [2]	1
CHEM 2546	Organic Chemistry Laboratory [2]	1
NEUR 3044	Cellular and Molecular Neuroscience [2]	3
NEUR 3084	Cognitive Neuroscience [2]	3
NEUR 4034	Diseases of the Nervous System [2]	3
PHYS 2205	General Physics [2]	3
PHYS 2206	General Physics [2]	3
PHYS 2215	General Physics Laboratory [2]	1
PHYS 2216	General Physics Laboratory [2]	1
STAT 3616	Biological Statistics [2]	3
Subtotal		32
Restricted Electives		
Select two of the following: [4,5]		6
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after one term of NEUR 2994)	
Select one of the following:		3
ALS 2304	Comparative Animal Physiology and Anatomy [2]	
ALS 4554	Neurochemical Regulation [2]	
BCHM 2024	Concepts of Biochemistry [2]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BIOL 2004	Genetics [2]	
BIOL 2134	Cell Function and Differentiation [2]	
BIOL 3404	Introductory Animal Physiology [2]	
BIOL 4824	Bioinformatics Methods [2]	
BMSP 2135	Human Anatomy & Physiology [2]	
BMSP 2136	Human Anatomy and Physiology [2]	
CHEM 4554	Drug Chemistry [2]	
CHEM 4615	Physical Chemistry for the Life Sciences [2]	
CHEM 4616	Physical Chemistry for the Life Sciences [2]	
NEUR 2464	Neuroscience and Society	
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3034	Global Perspectives Pre-Departure [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after two terms of undergraduate research at the 2994 level)	

PHYS 4714	Introduction to Biophysics [2]	
PSYC 2044	Psychology of Learning [2]	
PSYC 2064	Introduction to Neuroscience of Behavior [2]	
PSYC 4044	Advanced Learning [2]	
PSYC 4114	Cognitive Psychology [2]	
PSYC 4064	Physiological Psychology [2]	
PSYC 4074	Sensation and Perception [2]	
STAT 4204	Experimental Designs [2]	
Subtotal		9
Free Electives		
Select 12 credits of free electives		12
Subtotal		12
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [1]	3
MATH 1026	Elementary Calculus (5F) [1]	3
STAT 3615	Biological Statistics (5A) [2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 **Grade Requirements:** Students must earn a grade of "C-" or better in all core neuroscience coursework (CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology) or the equivalent coursework. Students must also earn a "C-" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1025 Elementary Calculus, and MATH 1026 Elementary Calculus. Only two attempts, including course withdrawals with a grade of "W," are allowed for each core neuroscience course, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1025 Elementary Calculus, and MATH 1026 Elementary Calculus.

2 **Prerequisites:** This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

3 Because PSYC 1004 Introductory Psychology is in the "Core" requirements, it *may not* double count as a concept 3 course.

4 Courses may not double count with the credits chosen for any other CNEU requirement.

5 If NEUR 4994 Undergraduate Research is selected, research must total 3 credits.

Grade Requirements and Progress Toward Degree Policy

Students must earn a grade of C- or better in the following neuroscience courses within 3 attempts: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable, MATH 1026 Elementary Calculus or MATH 1226 Calculus of a Single Variable, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology.

NEUR 1004 can be satisfied with any First-Year Experience course taken at Virginia Tech.
If you have transferred in any of the courses listed above with a C or better, or have equivalent AP/IB/CLEP credit, you have met the minimum grade requirement.

A withdrawal (W) counts as an attempt.

If these requirements are not met, you will be asked to leave the School of Neuroscience.

Graduation Requirements

Graduation Requirements

Student must complete a minimum of 120 credit hours with an overall GPA of 2.0 and a minimum in-major GPA of 2.0. For purposes of GPA computation, courses IN-MAJOR will include Core requirements, Major requirements, Restricted Electives, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, and MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus.

Double Majors/Minors

The School of Neuroscience offers majors in Cognitive and Behavioral Neuroscience, Clinical Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Courses for these majors

overlap slightly. Therefore, students may not pursue multiple majors within the School.

Prerequisites

This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Terminology

Pathways Requirements: Pathways to General Education is defined by the university as "A vibrant, flexible, and innovative general education program that provides a coherent and meaningful learning experience and allows students to integrate the learning for use throughout their lifetimes."

Core Neuroscience Requirements: Core neuroscience requirements are those requirements that must be fulfilled by all students in the School of Neuroscience, regardless of major.

Major Requirements: Major requirements are those requirements that are unique to the CNEU major and do not apply across all School of Neuroscience majors.

Restricted Elective: Restricted elective courses provide students the autonomy to select 9 or more credits of coursework within an approved list to count towards the students' degree requirements. These courses expand on the depth and breadth of the CNEU major.

Free Elective: Free elective credits may consist of any credit-bearing Virginia Tech coursework to ensure that students reach the 120 credits required by the university to earn a bachelor's degree. Coursework that does not apply elsewhere towards the degree will apply here (this includes non-duplicative coursework for double majors, minors, or AP coursework that does not count elsewhere towards the degree).

Acceptable Substitutions

Acceptable Substitutions

- CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab
- CHEM 2535 Organic Chemistry- CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory- CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab- CHEM 2556 Organic Synthesis and Techniques Lab
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus:MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1026 Elementary Calculus
- NEUR 1004 Neuroscience Orientation Seminar: Any approved FYE course
- PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics
- PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics
- STAT 3615 Biological Statistics-STAT 3616 Biological Statistics: STAT 3005 Statistical Methods-STAT 3006 Statistical Methods

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Cognitive and Behavioral Neuroscience Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
NEUR 1004	Neuroscience Orientation Seminar [1]	2
NEUR 2025	Introduction to Neuroscience [1,2]	3
NEUR 2026	Introduction to Neuroscience [1,2]	3
NEUR 2035	Neuroscience Laboratory [1]	1
NEUR 2036	Neuroscience Laboratory [1]	1
NEUR 4044	Neuroscience Senior Seminar [1,2]	3
PSYC 1004	Introductory Psychology [1,3]	3
Subtotal		22
Major Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
NEUR 3044	Cellular and Molecular Neuroscience [2]	3
NEUR 3084	Cognitive Neuroscience [2]	3
NEUR 3144	Mechanisms of Learning and Memory [2]	3
STAT 3616	Biological Statistics [2]	3
PHYS 2205	General Physics [2]	3
PHYS 2206	General Physics [2]	3
Subtotal		20
Restricted Electives		
Select four of the following: [4,5]		12
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	

NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after one term of NEUR 2994l)	
Select one of the following:		3
ALS 2304	Comparative Animal Physiology and Anatomy [2]	
ALS 4554	Neurochemical Regulation [2]	
BCHM 2024	Concepts of Biochemistry [2]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BIOL 2004	Genetics [2]	
BIOL 2134	Cell Function and Differentiation [2]	
BIOL 3404	Introductory Animal Physiology [2]	
BIOL 4824	Bioinformatics Methods [2]	
BMSP 2135	Human Anatomy & Physiology [2]	
BMSP 2136	Human Anatomy and Physiology [2]	
CHEM 1045	General Chemistry Laboratory	
CHEM 1046	General Chemistry Laboratory	
CHEM 2514	Survey of Organic Chemistry [2]	
CHEM 2535	Organic Chemistry [2]	
CHEM 2536	Organic Chemistry [2]	
CHEM 2545	Organic Chemistry Laboratory [2]	
CHEM 2546	Organic Chemistry Laboratory [2]	
CHEM 4554	Drug Chemistry [2]	
CHEM 4615	Physical Chemistry for the Life Sciences [2]	
CHEM 4616	Physical Chemistry for the Life Sciences [2]	
NEUR 2464	Neuroscience and Society	
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3034	Global Perspectives Pre-Departure [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after two terms of research at the 2994 level)	
PHYS 2215	General Physics Laboratory [2]	
PHYS 2216	General Physics Laboratory [2]	
PHYS 4714	Introduction to Biophysics [2]	
PSYC 4044	Advanced Learning [2]	
PSYC 4064	Physiological Psychology [2]	
PSYC 4074	Sensation and Perception [2]	
PSYC 4114	Cognitive Psychology [2]	
STAT 4204	Experimental Designs [2]	
Subtotal		15
Free Electives		
Select 18 credits of free electives		18
Subtotal		18
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSYC 2044	Psychology of Learning [2]	3
Select three credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [1]	3
MATH 1026	Elementary Calculus (5F) [1]	3
STAT 3615	Biological Statistics (5A) [2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		

Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)	3
Subtotal	45
Total Credits	**120**

1 **Grade Requirements:** Students must earn a grade of "C-" or better in all core neuroscience coursework (CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology) or the equivalent coursework. Students must also earn a "C-" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1225 Calculus of a Single Variable, and MATH 1226 Calculus of a Single Variable. Only two attempts, including course withdrawals with a grade of "W," are allowed for each core neuroscience course, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1025 Elementary Calculus, and MATH 1026 Elementary Calculus.

2 **Prerequisites:** This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

3 Because PSYC 1004 Introductory Psychology is in the "Core" requirements, it *may not* double count as a concept 3 course.

4 Courses may not double count with the credits chosen for any other CBNU requirement.

5 If NEUR 4994 Undergraduate Research is selected, research must total to 3 credits.

Grade Requirements and Progress Toward Degree Policy

Students must earn a grade of C- or better in the following neuroscience courses within 3 attempts: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable, MATH 1026 Elementary Calculus or MATH 1226 Calculus of a Single Variable, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology.

NEUR 1004 can be satisfied with any First-Year Experience course taken at Virginia Tech.
If you have transferred in any of the courses listed above with a C or better, or have equivalent AP/IB/CLEP credit, you have met the minimum grade requirement.

A withdrawal (W) counts as an attempt.

If these requirements are not met, you will be asked to leave the School of Neuroscience.

Graduation Requirements

Graduation Requirements

Student must complete a minimum of 120 credit hours with an overall GPA of 2.0 and a minimum in-major GPA of 2.0. For purposes of GPA computation, courses IN-MAJOR will include Core requirements, Major requirements, Restricted Electives, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, and MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus.

Double Majors/Minors

The School of Neuroscience offers majors in Cognitive and Behavioral Neuroscience, Clinical Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Courses for these majors overlap slightly. Therefore, students may not pursue multiple majors within the School.

Prerequisites

This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Terminology

Pathways Requirements: Pathways to General Education is defined by the university as "A vibrant, flexible, and innovative general education program that provides a coherent and meaningful learning experience and allows students to integrate the learning for use throughout their lifetimes."

Core Neuroscience Requirements: Core neuroscience requirements are those requirements that must be fulfilled by all students in the School of Neuroscience, regardless of major.

Major Requirements: Major requirements are those requirements that are unique to the CBNU major and do not apply across all School of Neuroscience majors.

Restricted Elective: Restricted elective courses provide students the autonomy to select 12 or more credits of coursework within an approved list to count towards the students' degree requirements. These courses expand on the depth and breadth of the CBNU major.

Free Elective: Free elective credits may consist of any credit-bearing Virginia Tech coursework to ensure that students reach the 120 credits required by the university to earn a bachelor's degree. Coursework that does not apply elsewhere towards the degree will apply here (this includes non-duplicative coursework for double majors, minors, or AP coursework that does not count elsewhere towards the degree).

Acceptable Substitutions

Acceptable Substitutions

- CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab

- CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1026 Elementary Calculus
- NEUR 1004 Neuroscience Orientation Seminar: Any approved FYE course
- PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics
- PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics
- STAT 3615 Biological Statistics- STAT 3616 Biological Statistics : STAT 3005 Statistical Methods- STAT 3006 Statistical Methods

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Computational and Systems Neuroscience Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
NEUR 1004	Neuroscience Orientation Seminar [1]	2
NEUR 2025	Introduction to Neuroscience [1,2]	3
NEUR 2026	Introduction to Neuroscience [1,2]	3
NEUR 2035	Neuroscience Laboratory [1]	1
NEUR 2036	Neuroscience Laboratory [1]	1
NEUR 4044	Neuroscience Senior Seminar [1,2]	3
PSYC 1004	Introductory Psychology [1,3]	3
Subtotal		22
Major Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CS 1114	Introduction to Software Design	3
NEUR 3044	Cellular and Molecular Neuroscience [2]	3
NEUR 3084	Cognitive Neuroscience [2]	3
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	3
NEUR 3234	The Artificial Brain [2]	3
PHYS 2305	Foundations of Physics [2]	4
PHYS 2306	Foundations of Physics [2]	4
STAT 3616	Biological Statistics	3
Subtotal		28
Restricted Electives		
Select two of the following: [4,5]		6
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after one term of NEUR 2994)	
Select one of the following: [4]		3
ALS 2304	Comparative Animal Physiology and Anatomy [2]	
ALS 4554	Neurochemical Regulation [2]	
BCHM 2024	Concepts of Biochemistry [2]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BIOL 2004	Genetics [2]	
BIOL 2134	Cell Function and Differentiation [2]	
BIOL 3404	Introductory Animal Physiology [2]	
BIOL 4824	Bioinformatics Methods [2]	
BMSP 2135	Human Anatomy & Physiology [2]	
BMSP 2136	Human Anatomy and Physiology [2]	
CHEM 1045	General Chemistry Laboratory	
CHEM 1046	General Chemistry Laboratory	
CHEM 2514	Survey of Organic Chemistry [2]	
CHEM 2535	Organic Chemistry [2]	
CHEM 2536	Organic Chemistry [2]	
CHEM 2545	Organic Chemistry Laboratory [2]	
CHEM 2546	Organic Chemistry Laboratory [2]	
CHEM 4554	Drug Chemistry [2]	

CHEM 4615	Physical Chemistry for the Life Sciences [2]	
CHEM 4616	Physical Chemistry for the Life Sciences [2]	
NEUR 2464	Neuroscience and Society	
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3034	Global Perspectives Pre-Departure [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3554	Neuroscience Research and Practical Experience [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after two terms of research at the 2994 level)	
PHYS 2504	Math Methods in Physics [2]	
PHYS 3314	Intermediate Laboratory [2]	
PHYS 3405	Intermediate Electricity and Magnetism [2]	
PHYS 3406	Intermediate Electricity and Magnetism [2]	
PHYS 3704	Thermal Physics [2]	
PHYS 4714	Introduction to Biophysics [2]	
PSYC 2044	Psychology of Learning [2]	
PSYC 2064	Introduction to Neuroscience of Behavior [2]	
PSYC 4044	Advanced Learning [2]	
PSYC 4114	Cognitive Psychology [2]	
PSYC 4064	Physiological Psychology [2]	
PSYC 4074	Sensation and Perception [2]	
STAT 4204	Experimental Designs [2]	
Subtotal		9
Free Electives		
Select remaining credits of free electives		14
Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable (5F) [1]	4
MATH 1226	Calculus of a Single Variable (5F) [1]	4
STAT 3615	Biological Statistics (5A) [1]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 **Grade Requirements:** Students must earn a grade of "C-" or better in all core neuroscience coursework (CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology) or the equivalent coursework. Students must also earn a "C-" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1225 Calculus of a Single Variable, and MATH 1226 Calculus of a Single Variable.

2 **Prerequisites:** This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

3 Because PSYC 1004 Introductory Psychology is in the "Core" requirements, it *may not* double count as a concept 3 course.

4 Courses may not double count with the credits chosen for any other CSNU requirement.

5 If NEUR 4994 Undergraduate Research is selected, research must total to 3 credits.

Grade Requirements and Progress Toward Degree Policy

Students must earn a grade of C- or better in the following neuroscience courses within 3 attempts: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry MATH 1225 Calculus of a Single Variable or MATH 1226 Calculus of a Single Variable, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025

Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology.

NEUR 1004 can be satisfied with any First-Year Experience course taken at Virginia Tech.
If you have transferred in any of the courses listed above with a C or better, or have equivalent AP/IB/CLEP credit, you have met the minimum grade requirement.

A withdrawal (W) counts as an attempt.

If these requirements are not met, you will be asked to leave the School of Neuroscience.

Graduation Requirements

Graduation Requirements

Student must complete a minimum of 120 credit hours with an overall GPA of 2.0 and a minimum in-major GPA of 2.0. For purposes of GPA computation, courses **in-major** will include Core requirements, Major requirements, Restricted Electives, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, and MATH 1225 Calculus of a Single Variable and MATH 1226 Calculus of a Single Variable.

Double Majors/Minors

The School of Neuroscience offers majors in Cognitive and Behavioral Neuroscience, Clinical Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Courses for these majors overlap slightly. Therefore, students may not pursue multiple majors within the School.

Prerequisites

This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Terminology

Pathways Requirements: Pathways to General Education is defined by the university as "A vibrant, flexible, and innovative general education program that provides a coherent and meaningful learning experience and allows students to integrate the learning for use throughout their lifetimes."

Core Neuroscience Requirements: Core neuroscience requirements are those requirements that must be fulfilled by all students in the School of Neuroscience, regardless of major.

Major Requirements: Major requirements are those requirements that are unique to the CSNU major and do not apply across all School of Neuroscience majors.

Restricted Elective: Restricted elective courses provide students the autonomy to select 9 or more credits of coursework within an approved list to count towards the students' degree requirements. These courses expand on the depth and breadth of the CSNU major.

Free Elective: Free elective credits may consist of any credit-bearing Virginia Tech coursework to ensure that students reach the 120 credits required by the university to earn a bachelor's degree. Coursework that does not apply elsewhere towards the degree will apply here (this includes non-duplicative coursework for double majors, minors, or AP coursework that does not count elsewhere towards the degree).

Acceptable Substitutions

Acceptable Substitutions

- CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab
- CHEM 2535 Organic Chemistry- CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory- CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab- CHEM 2556 Organic Synthesis and Techniques Lab
- CS 1114 Introduction to Software Design: CS 1064 Introduction to Programming in Python-CS 2064 Intermediate Programming in Python
- NEUR 1004 Neuroscience Orientation Seminar: Any approved FYE course
- STAT 3615 Biological Statistics-STAT 3616 Biological Statistics: STAT 3005 Statistical Methods-STAT 3006 Statistical Methods or CMDA 2005 Integrated Quantitative Sciences-CMDA 2006 Integrated Quantitative Sciences

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Experimental Neuroscience Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
CHEM 1035	General Chemistry [1]	3
CHEM 1036	General Chemistry [1]	3
NEUR 1004	Neuroscience Orientation Seminar [1]	2
NEUR 2025	Introduction to Neuroscience [1,2]	3
NEUR 2026	Introduction to Neuroscience [1,2]	3
NEUR 2035	Neuroscience Laboratory [1]	1
NEUR 2036	Neuroscience Laboratory [1]	1
NEUR 4044	Neuroscience Senior Seminar [1,2]	3
PSYC 1004	Introductory Psychology [1,3]	3
Subtotal		22

Major Requirements		
BIOL 1115	Principles of Biology Laboratory [1]	1
BIOL 1116	Principles of Biology Laboratory [1]	1
CHEM 1045	General Chemistry Laboratory	1
CHEM 1046	General Chemistry Laboratory	1
NEUR 3044	Cellular and Molecular Neuroscience [2]	3
NEUR 3084	Cognitive Neuroscience [2]	3
NEUR 3554	Neuroscience Research and Practical Experience [2]	3
PHYS 2205	General Physics [2]	3
PHYS 2206	General Physics [2]	3
PHYS 2215	General Physics Laboratory [2]	1
PHYS 2216	General Physics Laboratory [2]	1
STAT 3616	Biological Statistics [2]	3
Subtotal		24
Restricted Electives		
Select four of the following: [4,5]		*12*
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3144	Mechanisms of Learning and Memory [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain [2]	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after one term of NEUR 2994) [2]	
Select one of the following:		3
ALS 2304	Comparative Animal Physiology and Anatomy [2]	
ALS 4554	Neurochemical Regulation [2]	
BCHM 2024	Concepts of Biochemistry [2]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [2]	
BIOL 2004	Genetics [2]	
BIOL 2134	Cell Function and Differentiation [2]	
BIOL 3404	Introductory Animal Physiology [2]	
BIOL 4824	Bioinformatics Methods [2]	
BMSP 2135	Human Anatomy & Physiology [2]	
BMSP 2136	Human Anatomy and Physiology [2]	
CHEM 2514	Survey of Organic Chemistry [2]	
CHEM 2535	Organic Chemistry [2]	
CHEM 2536	Organic Chemistry [2]	
CHEM 2545	Organic Chemistry Laboratory [2]	
CHEM 2546	Organic Chemistry Laboratory	
CHEM 4554	Drug Chemistry [2]	
CHEM 4615	Physical Chemistry for the Life Sciences [2]	
CHEM 4616	Physical Chemistry for the Life Sciences [2]	
NEUR 2464	Neuroscience and Society	
NEUR 2554	Experimental Neuroscience [2]	
NEUR 2594	Exploring Clinical Neuroscience [2]	
NEUR 3034	Global Perspectives Pre-Departure [2]	
NEUR 3054	Brain-Body Interactions in Health and Disease [2]	
NEUR 3074	Evolutionary Neuroscience [2]	
NEUR 3234	The Artificial Brain [2]	
NEUR 3594	Neurobiology of Psychiatric Disorders [2]	
NEUR 3774	Neuroendocrinology [2]	
NEUR 3844	Computational Neuroscience and Neural Engineering [2]	
NEUR 3914	Neuroscience of Drug Addiction [2]	
NEUR 3944	War and the Brain	
NEUR 4034	Diseases of the Nervous System [2]	
NEUR 4054	Developmental Neuroscience [2]	
NEUR 4064	Neuropharmacology [2]	
NEUR 4314	Genetics in Neuroscience [2]	
NEUR 4364	Neuroscience of Language and Communication Disorders [2]	
NEUR/ECON/ PSYC 4454	Neuroeconomics [2]	
NEUR 4514	Neuroimmunology in Health and Disease [2]	
NEUR 4594	Clinical Neuroscience in Practice [2]	
NEUR 4814	Nutritional Neuroscience [2]	
NEUR 4914	Drug Development in Neuroscience [2]	
NEUR 4994	Undergraduate Research (may only be taken after two terms of research at the 2994 level)	
PHYS 4714	Introduction to Biophysics [2]	
PSYC 2044	Psychology of Learning [2]	
PSYC 2064	Introduction to Neuroscience of Behavior [2]	
PSYC 4044	Advanced Learning [2]	
PSYC 4064	Physiological Psychology [2]	
PSYC 4074	Sensation and Perception [2]	
PSYC 4114	Cognitive Psychology [2]	
STAT 4204	Experimental Designs [2]	
Subtotal		15
Free Electives		
Select 14 credits of free electives		14
Subtotal		14
Pathways to General Education		
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		6

Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology [1]	3
BIOL 1106	Principles of Biology [1]	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1025	Elementary Calculus (5F) [1]	3
MATH 1026	Elementary Calculus (5F) [1]	3
STAT 3615	Biological Statistics (5A) [2]	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Total Credits		**120**

1 **Grade Requirements:** Students must earn a grade of "C-" or better in all core neuroscience coursework (CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology) or the equivalent coursework. Students must also earn a "C-" or better in BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, MATH 1025 Elementary Calculus, and MATH 1026 Elementary Calculus.

2 **Prerequisites:** This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

3 Because PSYC 1004 Introductory Psychology is in the "Core" requirements, it *may not* double count as a concept 3 course.

4 Courses may not double count with the credits chosen for any other EXPN requirement.

5 If NEUR 4994 Undergraduate Research is selected, it must total 3 credit hours.

Grade Requirements and Progress Toward Degree Policy

Students must earn a grade of C- or better in the following neuroscience courses within 3 attempts: BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, CHEM 1035 General Chemistry, CHEM 1036 General Chemistry, MATH 1025 Elementary Calculus or MATH 1225 Calculus of a Single Variable, MATH 1026 Elementary Calculus or MATH 1226 Calculus of a Single Variable, NEUR 1004 Neuroscience Orientation Seminar, NEUR 2025 Introduction to Neuroscience, NEUR 2026 Introduction to Neuroscience, NEUR 2035 Neuroscience Laboratory, NEUR 2036 Neuroscience Laboratory, NEUR 4044 Neuroscience Senior Seminar, PSYC 1004 Introductory Psychology.

NEUR 1004 can be satisfied with any First-Year Experience course taken at Virginia Tech.

If you have transferred in any of the courses listed above with a C or better, or have equivalent AP/IB/CLEP credit, you have met the minimum grade requirement.

A withdrawal (W) counts as an attempt.

If these requirements are not met, you will be asked to leave the School of Neuroscience.

Graduation Requirements

Graduation Requirements

Student must complete a minimum of 120 credit hours with an overall GPA of 2.0 and a minimum in-major GPA of 2.0. For purposes of GPA computation, courses **in-major** will include Core requirements, Major requirements, Restricted Electives, BIOL 1105 Principles of Biology, BIOL 1106 Principles of Biology, BIOL 1115 Principles of Biology Laboratory, BIOL 1116 Principles of Biology Laboratory, and MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus.

Double Majors/Minors

The School of Neuroscience offers majors in Cognitive and Behavioral Neuroscience, Clinical Neuroscience, Computational and Systems Neuroscience, and Experimental Neuroscience. Courses for these majors overlap slightly. Therefore, students may not pursue multiple majors within the School.

Prerequisites

This check sheet contains courses that have at least one prerequisite that may not be included as part of this degree. Please see your advisor or consult the Undergraduate Course Catalog for more information.

Terminology

Pathways Requirements: Pathways to General Education is defined by the university as "A vibrant, flexible, and innovative general education program that provides a coherent and meaningful learning experience and allows students to integrate the learning for use throughout their lifetimes."

Core Neuroscience Requirements: Core neuroscience requirements are those requirements that must be fulfilled by all students in the School of Neuroscience, regardless of major.

Major Requirements: Major requirements are those requirements that are unique to the EXPN major and do not apply across all School of Neuroscience majors.

Restricted Elective: Restricted elective courses provide students the autonomy to select 12 or more credits of coursework within an approved list to count towards the students' degree requirements. These courses expand on the depth and breadth of the EXPN major.

Free Elective: Free elective credits may consist of any credit-bearing Virginia Tech coursework to ensure that students reach the 120 credits required by the university to earn a bachelor's degree. Coursework that does not apply elsewhere towards the degree will apply here (this includes non-duplicative coursework for double majors, minors, or AP coursework that does not count elsewhere towards the degree).

Acceptable Substitutions

Acceptable Substitutions

- CHEM 1035 General Chemistry-CHEM 1036 General Chemistry: CHEM 1055 General Chemistry for Chemistry Majors-CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory: CHEM 1065 General Chemistry for Chemistry Majors Lab-CHEM 1066 General Chemistry for Chemistry Majors Lab
- CHEM 2535 Organic Chemistry-CHEM 2536 Organic Chemistry: CHEM 2565 Principles of Organic Chemistry-CHEM 2566 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory-CHEM 2546 Organic Chemistry Laboratory: CHEM 2555 Organic Synthesis and Techniques Lab-CHEM 2556 Organic Synthesis and Techniques Lab
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable
- MATH 1025 Elementary Calculus-MATH 1026 Elementary Calculus: MATH 1225 Calculus of a Single Variable-MATH 1026 Elementary Calculus
- NEUR 1004 Neuroscience Orientation Seminar: Any approved FYE course
- PHYS 2205 General Physics, PHYS 2215 General Physics Laboratory: PHYS 2305 Foundations of Physics
- PHYS 2206 General Physics, PHYS 2216 General Physics Laboratory: PHYS 2306 Foundations of Physics
- STAT 3615 Biological Statistics- STAT 3616 Biological Statistics : STAT 3005 Statistical Methods- STAT 3006 Statistical Methods

Foreign Language Requirement

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Physics

Our Website (http://www.phys.vt.edu)

Overview

The physics curriculum is designed to provide a broad foundation in the physical sciences, as well as specialized training in classical and modern physics, and it may lead to either a B.S. or a B.A. An honors student may also qualify for a five-year program leading to both the B.S. and M.S. Experimental opportunities are available in such fields as fundamental particle physics, nuclear physics, condensed matter physics, biophysics, and astronomy. Students are encouraged to participate with faculty members in undergraduate research projects.

Multiple emphases in the physics curriculum permit students to give special attention to those aspects of the discipline they prefer and enable them either to pursue a traditional course of study as preparation for joining the technical staffs of industries or government laboratories, or for graduate studies in physics or astronomy (B.S.); or to pursue an interdisciplinary course of study with a strong background in physics (B.A.).

A handbook that includes sample curricula for emphases in astrophysics, biophysics, chemistry, computer science, education, electrical engineering, finance, geophysics, materials science, mathematics, physics education, pre-health, and pre-law is available from the department on request.

Majors

- Physics B.S. (Outstanding students may also elect to complete the requirements for a B.S. "in honors". A description of this honors program in physics is included in the handbook indicated above.)
- Physics B.A.
- Physics B.A. Physics Education Option
- Physics B.A. Pre-Health Option
- Physics B.A. Pre-Law Option

The department also offers the M.S. and Ph.D. in physics (see the Graduate Catalog).

Transfer students should contact the department early, preferably one full semester prior to entrance. This procedure will allow a thorough evaluation of transfer credits and correct placement.

The department participates in the Cooperative Education Program in which a student may alternate through two successive years a semester of study with a semester of professional employment in his/her discipline; these two years normally replace the student's sophomore year. Additional information on the program is included in the "Academics (p. 9)" section in this catalog and in the handbook indicated above.

Minors

A student may obtain a minor in physics or astronomy or biophysics, by registering with the department and successfully completing the approved minor requirements in effect at the time of graduation. Please visit the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html for minor requirements.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Pathways to General Education (see "Academics") and toward the degree.

Satisfactory progress requirements toward the B.S. and B.A. in Physics can be found on the major checksheet by visiting the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html.

- Physics Major (p. 1335)
- Physics Major (p. 1337)
- Physics Major with Physics Education Option (p. 1338)

- Physics Major with Pre-Health Option (p. 1340)
- Physics Major with Pre-Law Option (p. 1342)

Chair: M. L. Pitt
Professors: N. Arav, E. Barnes, S. Economou, J. R. Heflin, J. J. Heremans, P. Huber, G. Khodaparast, C. Mariani, J. M. Link, D. Minic, P.R. Montague, S.K. Mun, K. Park, L. E. Piilonen, M. L. Pitt, M. J. F. Pleimling, V. W. Scarola, E.R. Sharpe, J. H. Simonetti, T. Takeuchi, U. Tauber, and R. B. Vogelaar
Associate Professors: L. Anderson, S. Cheng, J. Gray, S. Horiuchi, V. Nguyen, T. O'Donnell, H. Robinson, I. Shoemaker, and V. Soghomonian
Assistant Professors: C. Ashall, R. Ashkar, M. Boer, S. Emori, and N. Kaplan
Assistant Collegiate Professors: B. Magill, and T. R. Merritt
Advanced Instructors: A. Khan and A. L. C. Robinson
Instructors: F. Lin, P. Nelson, D. Osborne, and K. Papavasiliou
Research Faculty: I. Ozcan and K. Wong
Adjunct Professors: C. D. Bowman, Z. Chang, D. Edmonds, M. Freedman, Y. Liang, G. R. Myneni, Z. Toroczkai, and C. Tao
Affiliated Faculty: L. Asryan[1], L. Guido[2], A. Onufriev[3], and M. Paul[4]
L.C. Hassinger Faculty Fellow: G. Khodaparast
Roger Moore and Mojdeh Khatam-Moore Faculty Fellow: P. Huber
William E. Hassinger, Jr., Senior Faculty Fellow in Physics: S. Economou

1 Regular appointment with Material Science and Engineering
2 Regular appointment with Materials Science & Engineering and Electrical & Computer Engineering
3 Regular appointment with Computer Science
4 Regular appointment with Mechanical Engineering

Undergraduate Course Descriptions (PHYS)

PHYS 1055 - Introduction to Astronomy (3 credits)
Survey course of astronomy topics ranging from the solar system to the universe, with Application of evidence-based reasoning, critical thinking, and use of theoretical models and observations. 1055 has a focus on the solar system: apparent sky motions, telescopes, matter and radiation, properties of the planets, structure and evolution of the solar system, cultural and intercultural aspects that influenced the understanding of the solar system, climate change as a Global challenge. 1056 has a focus on the universe: stars, star formation, stellar evolution, organization of the Milky Way Galaxy, galaxies, quasars, structure and evolution of the universe, cosmological models, cultural and intercultural aspects of the development of astronomical thought, life in the universe.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 1056 - Introduction to Astronomy (3 credits)
Survey course of astronomy topics ranging from the solar system to the universe, with Application of evidence-based reasoning, critical thinking, and use of theoretical models and observations. 1055 has a focus on the solar system: apparent sky motions, telescopes, matter and radiation, properties of the planets, structure and evolution of the solar system, cultural and intercultural aspects that influenced the understanding of the solar system, climate change as a Global challenge. 1056 has a focus on the universe: stars, star formation, stellar evolution, organization of the Milky Way Galaxy, galaxies, quasars, structure and evolution of the universe, cosmological models, cultural and intercultural aspects of the development of astronomical thought, life in the universe.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 1155 - Astronomy Laboratory (1 credit)
Simulation of apparent sky motions; observations of planets, stars, and nebulae with quantitative analysis; long term observations of sky changes; analysis of images; laboratory experiments of astrophysical relevance.
Corequisite(s): PHYS 1055
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 1156 - Astronomy Laboratory (1 credit)
Simulation of apparent sky motions; observations of planets, stars, and nebulae with quantitative analysis; long term observations of sky changes; analysis of images; laboratory experiments of astrophysical relevance.
Prerequisite(s): PHYS 1155
Corequisite(s): PHYS 1056
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2074 - Highlights of Contemporary Physics (3 credits)
Conceptual overview of modern scientific thinking in physics, with application of critical reasoning and quantitative and conceptual problem solving based on fundamental physics principles. Presentation of the key ideas and philosophical aspects of the most important developments in modern physics, such as quantum mechanics, relativity, particle physics, cosmology. Discussion of their impact on our understanding of the universe, our position in it, intercultural aspects, and the relevance of physics for technical challenges requiring global awareness.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2205 - General Physics (3 credits)
General physics course sequence for students in curricula other than physical sciences, mathematics, or engineering, who have not studied calculus. Applications of reasoning in the natural sciences using physical laws in a real-world context and in the students own discipline. Overview of intercultural and universal aspects of physics, and of human benefits of physics to address global challenges. 2205: mechanics, wave phenomena, fluids. 2206: optics, thermodynamics, electromagnetism, relativity, topics in nuclear and modern physics.
Prerequisite(s): MATH 1025 or MATH 1026 or MATH 1225 or MATH 1524
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2206 - General Physics (3 credits)
General physics course sequence for students in curricula other than physical sciences, mathematics, or engineering, who have not studied calculus. Applications of reasoning in the natural sciences using physical laws in a real-world context and in the students own discipline. Overview of intercultural and universal aspects of physics, and of human benefits of physics to address global challenges. 2205: mechanics, wave phenomena, fluids. 2206: optics, thermodynamics, electromagnetism, relativity, topics in nuclear and modern physics.
Prerequisite(s): (PHYS 2305 or PHYS 2205) and (MATH 1025 or MATH 1026 or MATH 1225 or MATH 1524)
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2215 - General Physics Laboratory (1 credit)
Laboratory experiments dealing with basic laws and techniques of physics; designed to illustrate topics covered in PHYS 2205-2206. Applications of reasoning in the natural sciences using physics experiments in a real-world and interdisciplinary context. Ethical responsibilities and issues in a laboratory setting. 2215: analysis of experimental errors, formatting for presenting graphical data, analyzing and describing and prioritizing experimental design features, communicating concepts orally and in writing, concepts of force, momentum, conservation of energy, wave and interference phenomena. 2216: analysis of experimental errors, communicating concepts orally and in writing, concepts of geometrical optics, optical instruments, heat and phase transitions, electricity and electrical energy storage, magnetic fields and magnetic induction, atomic spectra.
Corequisite(s): PHYS 2205
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2216 - General Physics Laboratory (1 credit)
Laboratory experiments dealing with basic laws and techniques of physics; designed to illustrate topics covered in PHYS 2205-2206. Applications of reasoning in the natural sciences using physics experiments in a real-world and interdisciplinary context. Ethical responsibilities and issues in a laboratory setting. 2215: analysis of experimental errors, formatting for presenting graphical data, analyzing and describing and prioritizing experimental design features, communicating concepts orally and in writing, concepts of force, momentum, conservation of energy, wave and interference phenomena. 2216: analysis of experimental errors, communicating concepts orally and in writing, concepts of geometrical optics, optical instruments, heat and phase transitions, electricity and electrical energy storage, magnetic fields and magnetic induction, atomic spectra.
Prerequisite(s): PHYS 2215 or PHYS 2305
Corequisite(s): PHYS 2206
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 2254 - Hello Quantum World! (3 credits)
Introduction to the concepts of quantum mechanics and quantum computing using a pictorial approach. Quantum bits, quantum superposition, quantum gate operations, quantum entanglement, and quantum measurements represented pictorially. Demonstration of quantum circuits and quantum algorithms. Use of cloud quantum processors with drag-and-drop interfaces. Quantum teleportation, no-cloning theorem, quantum key distribution. Use of the pictorial formalism to define the concept of vectors.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2305 - Foundations of Physics (4 credits)
Introductory sequence for students in physical sciences, mathematics, and engineering. Overview of intercultural contributions to physics and universal aspects of physics, and of human benefits of physics to address world-wide challenges. 2305: classical mechanics of translational and rotational motion, Newtonian gravitation, and thermal physics. 2306: oscillations, waves, electricity, magnetism, and optics.
Prerequisite(s): MATH 1225
Corequisite(s): MATH 1226
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 2306 - Foundations of Physics (4 credits)
Introductory sequence for students in physical sciences, mathematics, and engineering. Overview of intercultural contributions to physics and universal aspects of physics, and of human benefits of physics to address world-wide challenges. 2305: classical mechanics of translational and rotational motion, Newtonian gravitation, and thermal physics. 2306: oscillations, waves, electricity, magnetism, and optics.
Prerequisite(s): MATH 1226 and PHYS 2305
Corequisite(s): 2325 or (MATH 1206 or MATH 1206H or MATH 1226) for 2305.
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 2324 - Thermal Physics Module (1 credit)
Introduction to thermal physics; solids, liquids, and gases; moles, temperature, ideal gas law; work, heat, first law of thermodynamics, ideal gas processes; molecular speeds, pressure; heat engines, refrigerators, the second law of thermodynamics. Intended for transfer students whose introductory physics courses did not include thermal physics. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2325 - Seminar for Physics Majors (1 credit)
Introduction to the field of physics and to the Physics Department. Overview of modern physics topics such as special relativity, quantum mechanics, condensed matter, nuclear, and particle physics. Presentation of research activities in the department. Also provides more in-depth discussion of and math preparation for topics in 2305-2306. For physics majors.
Corequisite(s): PHYS 2305
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2326 - Seminar for Physics Majors (1 credit)
Introduction to the field of physics and the Physics Department. Overview of modern physics topics such as special relativity, quantum mechanics, condensed matter, nuclear, and particle physics. Presentation of research activities in the department. Also provides more in-depth discussion of and math preparation for topics in 2305-2306. For physics majors.
Prerequisite(s): PHYS 2325
Corequisite(s): PHYS 2306
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2334 - Waves and Sound Module (1 credit)
Introduction to mechanical waves and sound; one-dimensional waves, transverse waves, sinusoidal waves; sound waves; waves in two- and three-dimensions; power, intensity; the Doppler Effect; principle of superposition of waves; standing waves, standing waves on a string, standing sound waves; interference of waves, interference in two and three-dimensions. Intended for transfer students whose introductory physics courses did not include the topics of mechanical waves and sound. Pass/Fail only.
Prerequisite(s): PHYS 2305
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2344 - Optics Module (1 credit)
Introduction to ray and wave optics; the ray model for light; reflection and refraction; image formation by mirrors; image formation by lenses; lenses in combinations, optical instruments; the wave model of light; interference of light waves; diffraction of light waves. Intended for transfer students whose introductory physics courses did not include introductory optics. Pass/Fail only.
Corequisite(s): PHYS 2334
Instructional Contact Hours: (1 Lec, 1 Crd)

PHYS 2404 - Physics Outreach (2-19 credits)
Service learning through teaching. An early field experience for physics students who are interested in physics education. Visit local schools and host campus visits to teach K-12 students fundamental physics concepts by performing physics demonstrations and activities. Learn successful communication techniques, lead classroom discussions, and utilize pedagogical content knowledge to effectively organize physics presentations to the general public. Repeatable (no maximum).
Corequisite(s): PHYS 2305
Instructional Contact Hours: (2-19 Lec, 2-19 Crd)

PHYS 2504 - Math Methods in Physics (3 credits)
Applications of mathematical methods to physics. Topics include spatial coordinate systems, linear algebra techniques in coupled motions, series approximations of solutions to physical systems, extremum problems in physics, differential equations in mechanics, integration in two and three spatial dimensions, probability theory in thermal physics.
Prerequisite(s): PHYS 2305
Corequisite(s): 2306, (MATH 2214 or 2214H) and (MATH 2224 or 2204 or 2204H).
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 2964 - Field Study (1-9 credits)
Instructional Contact Hours: (1-19 Lec, 1-9 Crd)

PHYS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PHYS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 2994H - Undergraduate Research (1-19 credits)
Honors
Instructional Contact Hours: Variable credit course

PHYS 3154 - Observational Astrophysics (2 credits)
Telescopic observations of the moon, planets, stars, interstellar medium, and galaxies; astrophotography; digital imaging. Telescopes; virtual observing techniques and instruments; photographic and digital imaging systems. Astronomical data reduction and interpretation; digital image processing. Prior credit for PHYS 2154 precludes credit for 3154.
Prerequisite(s): PHYS 1156
Instructional Contact Hours: (1 Lec, 3 Lab, 2 Crd)

PHYS 3254 - Enriched Physics Outreach (3 credits)
Design and implementation of physics lesson plans for K-12 students at local schools and campus visits. Creation of inquiry-based, student-centered physics lessons which motivate and educate students of all ages. Development of activities and experiments to engage students in being scientists.
Corequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3314 - Intermediate Laboratory (3 credits)
Characteristics of common instrumentation and basic circuits, methods of producing good practices in data gathering, recording, and analysis.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

PHYS 3324 - Modern Physics (4 credits)
Photons and their interactions with matter, wave-particle duality, Heisenberg uncertainty principle, Schrodingers equation of motion, hydrogenic and multi-electron atoms, Pauli exclusion principle, molecules, solids, nuclei, elementary particles. Includes lab work. MATH 4544 can be substituted for co-requisite MATH 2214 or 2214H. Pre: 2306.
Prerequisite(s): PHYS 2306
Corequisite(s): MATH 2214 or MATH 2214H.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

PHYS 3355 - Intermediate Mechanics (3 credits)
Formal aspects of classical mechanics and dynamics. Topics include Newtonian, Lagrangian and Hamiltonian theory applied to non-relativistic systems in one, two, and three dimensions, relativistic dynamics, linear algebra applied to coupled many-body motion, small oscillations, and rigid body motion.
Prerequisite(s): (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204 and MATH 2214) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204 and MATH 2214H) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204H and MATH 2214) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2204H and MATH 2214H) or (PHYS 2305 and PHYS 2306 and PHYS 2504 and MATH 2406H)
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3356 - Intermediate Mechanics (3 credits)
Formal aspects of classical mechanics and dynamics. Topics include Newtonian, Lagrangian and Hamiltonian theory applied to non-relativistic systems in one, two, and three dimensions, relativistic dynamics, linear algrbra applied to coupled many-body motion, small oscillations, and rigid body motion.
Prerequisite(s): PHYS 3355
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3405 - Intermediate Electricity and Magnetism (3 credits)
Electrostatics, multipoles, Laplaces equation, and dielectric media. Magnetostatics, magnetic media, and electromagnetic induction. Maxwells equations, electromagnetic energy, waves, and radiation. Must meet pre-requisites and have a grade of C or better in each of 2305-2306 sequence.
Prerequisite(s): (MATH 2214 or MATH 2214H) and PHYS 2305 and PHYS 2306 and PHYS 2504
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3406 - Intermediate Electricity and Magnetism (3 credits)
Electrostatics, multipoles, Laplaces equation, and dielectric media. Magnetostatics, magnetic media, and electromagnetic induction. Maxwells equations, electromagnetic energy, waves, and radiation. Must meet pre-requisites and have a grade of C or better in each of 2305-2306 sequence.
Prerequisite(s): PHYS 3405
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3655 - Introduction to Astrophysics (3 credits)
Application of elementary physical laws to determine dimensions, masses, luminosities, structures, and evolution of astronomical objects and the universe as a whole. Emphasis is on quantitative derivation.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3656 - Introduction to Astrophysics (3 credits)
Application of elementary physical laws to determine dimensions, masses, luminosities, structures, and evolution of astronomical objects and the universe as a whole. Emphasis is on quantitative derivation.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 3684 - Quantum Software I (2 credits)
Organization of quantum information (assemblies of bits) for quantum-computing applications in chemistry, physics, biology, and computer science. Numerical methods for quantum software, emphasizing spin lattices and simulations such as quantum games. Best practices for programming, including techniques for quantum-coding (in Python or Julia), structuring a software product for quantum-computational science use, version control, and cloud-based documentation and code-sharing (via Github). Classical/quantum translation.
Prerequisite(s): MATH 2114 or MATH 2114H or MATH 3144
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: CHEM 3684

PHYS 3704 - Thermal Physics (3 credits)
Introduction to the concepts, formalism, and applications of classical and quantum statistical mechanics, including thermodynamics.
Prerequisite(s): PHYS 2306 and PHYS 3324
Corequisite(s): 2504, (MATH 2214 or 2214H).
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4224 - Physics Teaching and Learning (2 credits)
Seminar course on how people learn and understand key concepts in physics to encourage more effective teaching strategies. Discussions of readings in physics, physics education research, and cognitive science. Recognition of common student preconceptions of physics concepts and identification of strategies which help to elicit conceptual change. Field work teaching precollege or college students. For students interested in teaching and learning physics, graduate teaching assistants, and undergraduate learning assistants.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (2 Lec, 2 Crd)

PHYS 4254 - Quantum Information Technologies (3 credits)
Quantum computing and other quantum information technologies. Differences between bit and qubit. Quantum logic gates, concept of entanglement, quantum teleportation, quantum cryptography and key distribution, quantum computing algorithms, including Deutsch-Jozsa algorithm, Grovers search algorithm, Shors factoring algorithm. Basics of public-key cryptosystems and number theory as needed to present Shors algorithm. Errors in a quantum computer and quantum error correction.
Prerequisite(s): MATH 2114 or MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4264 - Quantum Optics and Qubit Processors (3 credits)
Quantum optics and quantum bit (qubit) platforms for quantum technology applications. Qubit as physical system, quantum unitary evolution as quantum gate, quantum control using electromagnetic fields, Rabi oscillations, adiabatic theorem, density matrix, Liouville-von Neumann equation, decay and decoherence (T1 and T2), spin echo, Ramsey interferometry, coherent population trapping, entanglement, dynamical maps, electromagnetic field quantization, Jaynes-Cummings Hamiltonian, spontaneous emission, solid-state qubit platforms (spin qubits, superconducting qubits), atomic qubit platforms (trapped ions), color-centers in solids.
Prerequisite(s): PHYS 4455
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4315 - Modern Experimental Physics (2 credits)
Representative apparatus, techniques, and phenomena of contemporary research. Includes electrical measurements, computers, thermometry, vacuum deposition, machine shop, nuclear spectra, experimentation related to major developments of modern physics.
Prerequisite(s): PHYS 3314
Instructional Contact Hours: (6 Lab, 2 Crd)

PHYS 4316 - Modern Experimental Physics (2 credits)
Representative apparatus, techniques, and phenomena of contemporary research. Includes electrical measurements, computers, thermometry, vacuum deposition, machine shop, nuclear spectra, experimentation related to major developments of modern physics.
Prerequisite(s): PHYS 3314 and PHYS 4315
Instructional Contact Hours: (6 Lab, 2 Crd)

PHYS 4455 - Introduction to Quantum Mechanics (3 credits)
Experimental bases; postulates; conservation theorems and symmetry; one-dimensional and two-dimensional problems; angular momentum and problems in three dimensions; matrix mechanics and spin; applications to atomic and molecular physics; perturbation theory; scattering.
Prerequisite(s): PHYS 3355
Corequisite(s): PHYS 3406
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4456 - Introduction to Quantum Mechanics (3 credits)
Experimental bases; postulates; conservation theorems and symmetry; one-dimensional and two-dimensional problems; angular momentum and problems in three dimensions; matrix mechanics and spin; applications to atomic and molecular physics; perturbation theory; scattering.
Prerequisite(s): PHYS 4455
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4504 - Introduction to Nuclear and Particle Physics (3 credits)
Structure and properties of atomic nuclei and elementary particles, theoretical interpretations based on elementary quantum mechanics. Symmetries; various nuclear models; interactions at small distances; classification of elementary particles. Consent required.
Corequisite(s): PHYS 4456
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4514 - Introduction to Nuclear Physics (3 credits)
Nuclear properties and nuclear interactions. Nuclear reactions and radioactive decays, including alpha, beta and gamma decays. Theoretical models of the nucleus and their interpretations. Experimental methods in nuclear physics. Applications, including nuclear power production.
Prerequisite(s): PHYS 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4524 - Intro Particle Physics (3 credits)
Relativistic kinematics. Particle interaction amplitudes and cross sections. Particle types including quarks, hadrons, leptons and bosons. Experimental methods in particle physics. Symmetries. The quark model. Weak interactions and electroweak unification. Particle physics beyond the Standard Model.
Prerequisite(s): PHYS 3324
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4534 - Quantitative Analysis of Physics Experiments (3 credits)
Statistical analysis of physics experiments. Probabilistic elements in experiments. Data analysis frameworks in physics subfields. Maximum likelihood estimation and Bayesian techniques. Physical principles and nuisance parameters. Analysis strategies and computational methods. Graphical data representation.
Prerequisite(s): PHYS 2504 and PHYS 3324 and CS 1064
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4554 - Introduction to Solid State Physics (3 credits)
Basic concepts of solid state physics including crystal structure, lattice vibrations, electron states, energy bands, semiconductors, metals. Consent required.
Corequisite(s): PHYS 4456
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4564 - Polymer Physics (3 credits)
Introduction to the field of polymer physics. Statistical descriptions of polymers based on Brownian motion and random walk models. Conformations and single chains. Thermodynamics of polymer mixtures, solutions, and melts. Properties of polymer networks. Polymer dynamics in both melt and solution states.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4574 - Nanotechnology (3 credits)
Introduction to methods of controlling matter on the nanometer length scale and the applications thereof. Nanolithography, self-assembly, and scanned probe microscopy; nanomaterials including fullerenes, carbon nanotubes, and quantum dots; nanoscale and molecular electronics; nanoelectromechanical systems; nanoscale optoelectronics; and nanobiotechnology.
Prerequisite(s): PHYS 2205 and PHYS 2206 or PHYS 2305 and PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4614 - Optics (3 credits)
Fundamentals of the ray, wave and quantum models of light, and topics in modern optics with contemporary applications.
Prerequisite(s): PHYS 2306 and (MATH 2214 or MATH 2214H) and (MATH 2224 or MATH 2204 or MATH 2204H)
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4624 - Optics Laboratory (1 credit)
Laboratory experiments dealing with ray and wave optical phenomena designed to illustrate and complement the principles covered in OPTICS PHYS 4614. Physics majors are required to take 4624 concurrently with the lecture course 4614.
Corequisite(s): PHYS 4614
Instructional Contact Hours: (3 Lab, 1 Crd)

PHYS 4634 - Modern Classical Physics (3 credits)
Geometric formulation of classical physics. Applications in relativity, optics, elasticity, fluid mechanics, plasma physics. Real-world examples from fundamental, experimental, and applied physics. Quantum roots of and quantum techniques in classical physics. Geometrical connections between classical mechanics, optics, and quantum physics. Problems in and connections between elasticity, fluid dynamics, magnetohydrodynamics, and plasma physics.
Prerequisite(s): PHYS 3355 and PHYS 3405
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4654 - Modern Cosmology (3 credits)
Survey of our current understanding of the origin, evolution, and fate of the Universe. Observational evidence behind the idea of the hot Big Bang, including the linear velocity-distance law, the existence of the cosmic microwave background, and the arguments for dark matter. Physics of a dynamic, expanding Universe via the Friedman-Lemaitre- Robertson-Walker metric. Physical principles to determine the conditions in the early Universe, introducing the idea of inflation. Mechanisms driving the origin and evolution of galaxies and large-scale structures.
Prerequisite(s): PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4664 - Astroparticle Physics (3 credits)
Observations of high-energy photons, cosmic rays, and neutrinos. Energy-loss interactions in astrophysical environments. Propagation of cosmic particles and ultra-high energy cosmic rays. Origins of cosmic rays. Astrophysical neutrinos and neutrino oscillations. Stellar evolution and evolution into supernova explosions. Mechanisms of astrophysical particle acceleration. Multi-messenger astronomy.
Prerequisite(s): PHYS 3655 or PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4674 - Introduction to General Relativity (3 credits)
Introduction to methods and applications of Einsteins general theory of relativity. Space and time and gravity in Newtonian physics; special theory of relativity, gravity as geometry of curved space-time; black holes; cosmology; Einsteins gravitational field equations; gravitational waves and relativistic stars.
Prerequisite(s): (MATH 2214 or MATH 2214H or MATH 2514) and PHYS 3355
Corequisite(s): PHYS 3406
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4684 - Quantum Software II (1 credit)
Modern software collaboration techniques and tools including collaborative code repositories and cloud-based documentation. Application of structure and version control to software and documentation. Developing code with industry-standard quantum-software modules. Hands-on scientific coding for quantum problems. Project management skills including proposal development and technical presentation delivery.
Prerequisite(s): CHEM 3684 or PHYS 3684
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: CHEM 4684

PHYS 4714 - Introduction to Biophysics (3 credits)
Selected topics from the general area of biomechanics, bioelectricity, radiation biophysics, molecular biophysics, and thermodynamics and transport in biological systems. Emphasis on the physical aspects of biological phenomena and biophysical measurement techniques and instrumentation.
Prerequisite(s): PHYS 2206 or PHYS 2306 or ISC 2106H
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4724 - Soft Matter Physics (3 credits)
Physical characteristics of various soft matter systems including liquids, liquid crystals, polymers, colloids, surfactants, granular materials, and biological soft materials. Van der Waals and electrostatic interactions in the context of soft matter. Descriptions of soft matter phases, phase diagrams, phase separation, and phase transitions. Theories of self-assembly and self-organization. Problems in and connections between elasticity, viscoelasticity, and mechanics of fluids including capillarity and wetting. Model of random walk and its applications to colloidal systems. Applications of variational methods in soft matter. Computer simulation methods in soft matter.
Prerequisite(s): PHYS 2306
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4755 - Introduction to Computational Physics (3 credits)
Survey of computational methods in physics. 4755: Applications in physics of curve fitting, numerical calculus, ordinary and partial differential equations, numerical methods for matrices, spectral analysis, and N-body systems. 4756: Investigation of physical systems using Molecular Dynamics simulations, Monte Carlo simulations, genetic algorithm and numerical renormalization. Introduction to advanced techniques, as for example density matrix renormalization group method, matrix product state approach, smoothed particle hydrodynamics, and density functional theory.
Prerequisite(s): PHYS 2306 and CS 1044 or CS 1054 or CS 1064 or CS 1114 or ECE 1574 or AOE 2074 or ESM 2074
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4756 - Introduction to Computational Physics (3 credits)
Survey of computational methods in physics. 4755: Applications in physics of curve fitting, numerical calculus, ordinary and partial differential equations, numerical methods for matrices, spectral analysis, and N-boyd systems. 4756: Investigation of physical systems using Molecular Dynamics simulations, Monte Carlo simulations, genetic algorithm and numerical renormalization. Introduction to advanced techniques, as for example density matrix renormalization group method, matrix product state approach, smoothed particle hydrodynamics, and density functional theory.
Prerequisite(s): PHYS 4455 and PHYS 4755
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4774 - Intro to Physics of Galaxies (3 credits)
Survey of our current observational and theoretical understanding of the formation and evolution of galaxies. Observational review of galaxy sizes and compositions, including the origin of the Hubble sequence. Physical description of a galaxy via distribution functions and stellar orbits. Time evolution of the distribution function. The Schwarzschild method for determining orbits. The physics of active galaxies.
Prerequisite(s): PHYS 3656
Instructional Contact Hours: (3 Lec, 3 Crd)

PHYS 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PHYS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHYS 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Physics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
PHYS 2504	Math Methods in Physics [1]	3
PHYS 3314	Intermediate Laboratory	3
PHYS 3324	Modern Physics [1]	4
PHYS 3355	Intermediate Mechanics [1]	3
PHYS 3405	Intermediate Electricity and Magnetism [1]	3
PHYS 3704	Thermal Physics [1]	3
PHYS 4315	Modern Experimental Physics [1]	2
Subtotal		21
Option Required Courses [2]		
PHYS 2325 & PHYS 2326	Seminar for Physics Majors and Seminar for Physics Majors [1]	2
MATH 2114 or MATH 2114H	Introduction to Linear Algebra [1] Introduction to Linear Algebra	3
MATH 2204 or MATH 2204H	Introduction to Multivariable Calculus [1] Introduction to Multivariable Calculus	3
MATH 3214	Calculus of Several Variables [1]	3
Select one of the following:		2
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering	
AOE/ESM 2074	Computational Methods [1]	
Subtotal		13
Restricted Electives		
Select two of the following:		6
PHYS 3655	Introduction to Astrophysics [1]	
PHYS 3656	Introduction to Astrophysics [1]	
PHYS 4254	Quantum Information Technologies [1]	
PHYS 4264	Quantum Optics and Qubit Processors [1]	
PHYS 4514	Introduction to Nuclear Physics [1]	
PHYS 4524	Intro Particle Physics	
PHYS 4534	Quantitative Analysis of Physics Experiments	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 4564	Polymer Physics [1]	
PHYS 4574	Nanotechnology [1]	
PHYS 4614	Optics [1]	
PHYS 4634	Modern Classical Physics [1]	

PHYS 4654	Modern Cosmology [1]	
PHYS 4664	Astroparticle Physics [1]	
PHYS 4674	Introduction to General Relativity [1]	
PHYS 4714	Introduction to Biophysics [1]	
PHYS 4724	Soft Matter Physics [1]	
PHYS 4755	Introduction to Computational Physics [1]	
PHYS 4774	Intro to Physics of Galaxies [1]	
Subtotal		6
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		
Select 31 credits		31
Subtotal		31
Pathways to General Education		
Pathways Concept 1 - Discourse [3]		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences [3]		
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
Pathways Concept 5 - Quantitative and Computational Thinking [3]		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214 or MATH 2214H	Introduction to Differential Equations (5A) [1] Introduction to Differential Equations	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits. 3 in design + 3 in arts, or 6 in integrated design & arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. Indicates a course with prerequisites or corequisites.
2. MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable[1] and MATH 2214 Introduction to Differential Equations[1] or MATH 2214H Introduction to Differential Equations[1] and PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics[1] are also required of all Physics Majors within the B.A. Degree Program in Physics. They are listed in Pathways to General Education Requirements.
3. The following course sequence is required of all students majoring in Physics within the B.A. Degree in Physics.

A student will be certified as making satisfactory progress toward the B.A. degree in Physics by satisfying the university's academic eligibility requirements, as well as the following requirements:

- Upon having attempted 60 credit hours, the student will have completed Concept 1 requirements, the Mathematics requirements as well as PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics, PHYS 2325 Seminar for Physics Majors-PHYS 2326Seminar for Physics Majors, PHYS 2504 Math Methods in Physics, and PHYS 3324 Modern Physics.
- Upon having attempted 45 credit hours, the student must have 2.0 overall and in-major GPAs. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.
- Upon having attempted 72 credit hours, the student will have completed the foreign language requirement by the close of the academic year (spring semester). [College of Science requirement]
- Upon having attempted 96 credit hours, the student will have completed all credits for the Pathways to General Education.

Graduation Requirements

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Department Chair.

Minimum Hours and GPA Required for Graduation

A minimum of 120 credit hours must be completed for graduation. A minimum overall and in-major GPA of 2.0 is required for graduation. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.

Prerequisites and Corequisites

Courses in this program have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Acceptable Substitutions

- PHYS 3355 Intermediate Mechanics may be substituted with AOE 3154 Astromechanics, **or** ESM 3124 Dynamics II- Analytical and 3-D Motion
- PHYS 3405 Intermediate Electricity and Magnetism may be substituted with ECE 3105 Electromagnetic Fields
- PHYS 3314 Intermediate Laboratory may be substituted with AOE 3054 Experimental Methods, **orECE 2214 Physical Electronics** & ECE 2274 Electronic Networks Laboratory I, **or** ESM 3444 Mechanics Laboratory

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward

the credits required for graduation. Please consult the Undergraduate Course Catalog for details.

Physics Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
PHYS 2504	Math Methods in Physics [1]	3
PHYS 3314	Intermediate Laboratory	3
PHYS 3324	Modern Physics [1]	4
PHYS 3355	Intermediate Mechanics [1]	3
PHYS 3405	Intermediate Electricity and Magnetism [1]	3
PHYS 3704	Thermal Physics [1]	3
PHYS 4315	Modern Experimental Physics [1]	2
Subtotal		21
Additional Course Requirements [2]		
PHYS 2325 & PHYS 2326	Seminar for Physics Majors and Seminar for Physics Majors [1]	2
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
PHYS 3406	Intermediate Electricity and Magnetism [1]	3
PHYS 4316	Modern Experimental Physics [1]	2
PHYS 4455 & PHYS 4456	Introduction to Quantum Mechanics and Introduction to Quantum Mechanics [1]	6
MATH 2114	Introduction to Linear Algebra [1]	3
or MATH 2114H	Introduction to Linear Algebra	
MATH 2204	Introduction to Multivariable Calculus [1]	3
or MATH 2204H	Introduction to Multivariable Calculus	
MATH 3214	Calculus of Several Variables [1]	3
MATH 4425	Fourier Series and Partial Differential Equations [1]	3
or MATH 4564	Operational Methods for Engineers	
Select one of the following:		1
MATH 3574	Applied Complex Variables [1]	
MATH 4234	Elementary Complex Analysis [1]	
MATH 4574	Vector and Complex Analysis for Engineers [1]	
Select one of the following:		2
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
AOE/ESM 2074	Computational Methods [1]	
ECE 2514	Computational Engineering	
Subtotal		36
Restricted Electives		
Select three of the following		9
PHYS 4254	Quantum Information Technologies [1]	
PHYS 4264	Quantum Optics and Qubit Processors	
PHYS 4514	Introduction to Nuclear Physics [1]	
PHYS 4524	Intro Particle Physics [1]	
PHYS 4534	Quantitative Analysis of Physics Experiments [1]	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 4564	Polymer Physics [1]	
PHYS 4574	Nanotechnology [1]	
PHYS 4614	Optics [1]	
PHYS 4634	Modern Classical Physics [1]	
PHYS 4654	Modern Cosmology [1]	
PHYS 4664	Astroparticle Physics [1]	
PHYS 4674	Introduction to General Relativity [1]	
PHYS 4714	Introduction to Biophysics [1]	
PHYS 4724	Soft Matter Physics	
PHYS 4755	Introduction to Computational Physics [1]	
PHYS 4774	Intro to Physics of Galaxies [1]	
Subtotal		9
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		
Select 5 credits		5
Subtotal		5
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences [2]		
CHEM 1035	General Chemistry [1]	3
CHEM 1045	General Chemistry Laboratory [1]	1
CHEM 1036	General Chemistry [1]	3
CHEM 1046	General Chemistry Laboratory [1]	1
Pathways Concept 5 - Quantitative and Computational Thinking [2]		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A) [1]	3
or MATH 2214H	Introduction to Differential Equations	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits. 3 in design + 3 in arts, or 6 in integrated design & arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. Course with prerequisites or corequisites.
2. MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable and MATH 2214 Introduction to Differential Equations or MATH 2214H Introduction to Differential Equations and CHEM 1035 General Chemistry-CHEM 1036 General Chemistry and CHEM 1045 General Chemistry Laboratory-CHEM 1046 General Chemistry Laboratory are also required of all Physics Majors within

the B.S. Degree Program in Physics. They are listed in the Pathways to General Education section above.

A student will be certified as making satisfactory progress toward the B.S. degree in Physics by satisfying the university's academic eligibility requirements, as well as the following requirements:

- Upon having attempted 60 credit hours, the student will have completed Pathways Concept 1 and Concept 4 requirements, the Mathematics requirements (in Pathways and Additional Course Requirements) as well as PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics, PHYS 2504 Math Methods in Physics, and PHYS 3324 Modern Physics.
- Upon having attempted 45 credit hours, the student must have 2.0 overall and in-major GPAs. All PHYS courses attempted are used in the calculation of the in-major GPA.
- Upon having attempted 96 credit hours, the student will have completed PHYS 3314 Intermediate Laboratory,PHYS 3355 Intermediate Mechanics and PHYS 3405 Intermediate Electricity and Magnetism-PHYS 3406 Intermediate Electricity and Magnetism.
- Upon having attempted 72 credit hours, the student will have completed the foreign language requirement by the close of the academic year (spring semester). [College of Science requirement]
- Upon having attempted 96 credit hours, the student will have completed all credits for the Pathways to General Education.

Graduation Requirements

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Department Chair.

Minimum Hours and GPA Required for Graduation

A minimum of 120 credit hours must be completed for graduation. A minimum overall and in-major GPA of 2.0 is required for graduation. All physics courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.

Prerequisites and Corequisites

Courses in this checksheet have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Acceptable Substitutions

- PHYS 3355 Intermediate Mechanics may be substituted with AOE 3154 Astromechanics, **or** ESM 3124 Dynamics II- Analytical and 3-D Motion.
- PHYS 3405 Intermediate Electricity and Magnetism may be substituted with ECE 3105 Electromagnetic Fields.
- PHYS 3406 Intermediate Electricity and Magnetism may be substituted with ECE 3106 Electromagnetic Fields.
- PHYS 3314 Intermediate Laboratory may be substituted with AOE 3054 Experimental Methods, **or** ECE 2214 Physical Electronics & ECE 2274 Electronic Networks Laboratory I, **or** ESM 3444 Mechanics Laboratory.
- PHYS 4316 Modern Experimental Physics may be substituted with PHYS 3154 Observational Astrophysics.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the credits required for graduation. Please consult the Undergraduate Course Catalog for details.

Physics Major with Physics Education Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
PHYS 2504	Math Methods in Physics [1]	3
PHYS 3314	Intermediate Laboratory	3
PHYS 3324	Modern Physics [1]	4
PHYS 3355	Intermediate Mechanics [1]	3
PHYS 3405	Intermediate Electricity and Magnetism [1]	3
PHYS 3704	Thermal Physics [1]	3
PHYS 4315	Modern Experimental Physics [1]	2
Subtotal		21
Option Required Courses [2]		
PHYS 2325 & PHYS 2326	Seminar for Physics Majors and Seminar for Physics Majors [1]	2
PHYS 3655 or PHYS 3656	Introduction to Astrophysics [1] Introduction to Astrophysics	3
MATH 2114 or MATH 2114H	Introduction to Linear Algebra [1] Introduction to Linear Algebra	3
MATH 2204 or MATH 2204H	Introduction to Multivariable Calculus [1] Introduction to Multivariable Calculus	3
MATH 3214	Calculus of Several Variables [1]	3
Select one of the following:		2
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
ECE 2514	Computational Engineering	
AOE/ESM 2074	Computational Methods [1]	
Subtotal		16
Science Courses		
Select 20-22 credit from one of the following four emphases:		20
Astronomy Emphasis		
PHYS 1055/1056	Introduction to Astronomy	
PHYS 1155/1156	Astronomy Laboratory	
PHYS 2114		
PHYS 3154	Observational Astrophysics [1]	
PHYS 3655 or PHYS 3656	Introduction to Astrophysics [3] Introduction to Astrophysics	

BIOL 1105	Principles of Biology	
CHEM 1035	General Chemistry [1]	
Biology Emphasis		
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory	
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory	
BIOL course [4]		
BIOL course [4]		
PHYS 1055 or GEOS 1004	Introduction to Astronomy Earth Science: Our Past, Present, and Future	
CHEM 1035	General Chemistry [1]	
Chemistry Emphasis		
CHEM 1035 & CHEM 1036	General Chemistry and General Chemistry [1]	
CHEM 1045 & CHEM 1046	General Chemistry Laboratory and General Chemistry Laboratory [1]	
CHEM course [4]		
CHEM course [4]		
PHYS 1055 or GEOS 1004	Introduction to Astronomy Earth Science: Our Past, Present, and Future	
BIOL 1105	Principles of Biology	
Geology Emphasis		
GEOS 1004	Earth Science: Our Past, Present, and Future	
GEOS 1104	Introduction to Earth Sciences Laboratory	
GEOS 1024	Earth Resources, Society, and Environment	
GEOS 1124	Earth Resources, Society and Environment Laboratory	
GEOS course [4]		
GEOS course [4]		
BIOL 1105	Principles of Biology	
CHEM 1035	General Chemistry [1]	
Subtotal		20
Restricted Electives		
Select one of the following:		3
PHYS 4254	Quantum Information Technologies [1]	
PHYS 4264	Quantum Optics and Qubit Processors [1]	
PHYS 4514	Introduction to Nuclear Physics [1]	
PHYS 4524	Intro Particle Physics [1]	
PHYS 4534	Quantitative Analysis of Physics Experiments [1]	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 4564	Polymer Physics [1]	
PHYS 4574	Nanotechnology [1]	
PHYS 4614	Optics [1]	
PHYS 4634	Modern Classical Physics [1]	
PHYS 4654	Modern Cosmology [1]	
PHYS 4664	Astroparticle Physics [1]	
PHYS 4674	Introduction to General Relativity [1]	
PHYS 4714	Introduction to Biophysics [1]	
PHYS 4724	Soft Matter Physics [1]	
PHYS 4755	Introduction to Computational Physics [1]	
PHYS 4774	Intro to Physics of Galaxies [1]	
Subtotal		3
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		
Select 8-11 credits		11
Pathways to General Education		
Pathways Concept 1 - Discourse [5]		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences [5]		
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
Pathways Concept 5 - Quantitative and Computational Thinking [5]		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214 or MATH 2214H	Introduction to Differential Equations (5A) [1] Introduction to Differential Equations	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits. 3 in design + 3 in arts, or 6 in integrated design & arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Total Credits		**120**

1. Indicates a course with prerequisites or corequisites.
2. MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable[1] and MATH 2214 Introduction to Differential Equations[1] or MATH 2214H Introduction to Differential Equations[1] and PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics[1] are also required of all Physics Majors within the B.A. Degree Program in Physics. They are listed in Pathways to General Education Requirements.
3. Exclusive of the choice made in Option Required Courses.
4. 2000-level or higher. These courses may have prerequisites or corequisites
5. The following course sequence is required of all students majoring in Physics within the B.A. Degree in Physics.

A student will be certified as making satisfactory progress toward the B.A. degree in Physics by satisfying the university's academic eligibility requirements, as well as the following requirements:

- Upon having attempted 60 credit hours, the student will have completed Concept 1 requirements, the Mathematics requirements as well as PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics, PHYS 2325 Seminar for Physics Majors-PHYS 2326 Seminar for Physics Majors, PHYS 2504 Math Methods in Physics, and PHYS 3324 Modern Physics.

- Upon having attempted 45 credit hours, the student must have 2.0 overall and in-major GPAs. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.
- Upon having attempted 72 credit hours, the student will have completed the foreign language requirement by the close of the academic year (spring semester). [College of Science requirement]
- Upon having attempted 96 credit hours, the student will have completed all credits for the Pathways to General Education.

Graduation Requirements

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Department Chair.

Minimum Hours and GPA Required for Graduation

A minimum of 120 credit hours must be completed for graduation. A minimum overall and in-major GPA of 2.0 is required for graduation. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.

Prerequisites and Corequisites

Courses in this checksheet marked with Footnote 1 have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Acceptable Substitutions

- PHYS 3355 Intermediate Mechanics may be substituted with AOE 3154 Astromechanics , **or** ESM 3124 Dynamics II- Analytical and 3-D Motion
- PHYS 3405 Intermediate Electricity and Magnetism may be substituted with ECE 3105 Electromagnetic Fields
- PHYS 3314 Intermediate Laboratory may be substituted with AOE 3054 Experimental Methods , **or** ECE 2214 Physical Electronics & ECE 2274 Electronic Networks Laboratory I , **or** ESM 3444 Mechanics Laboratory

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the credits required for graduation. Please consult the Undergraduate Course Catalog for details.

Physics Major with Pre-Health Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
PHYS 2504	Math Methods in Physics [1]	3
PHYS 3314	Intermediate Laboratory	3
PHYS 3324	Modern Physics [1]	4
PHYS 3355	Intermediate Mechanics [1]	3
PHYS 3405	Intermediate Electricity and Magnetism [1]	3
PHYS 3704	Thermal Physics [1]	3
PHYS 4315	Modern Experimental Physics [1]	2
Subtotal		21
Option Required Courses [2]		
PHYS 2325 & PHYS 2326	Seminar for Physics Majors and Seminar for Physics Majors [1]	2
MATH 2114	Introduction to Linear Algebra [1]	3
or MATH 2114H	Introduction to Linear Algebra	
MATH 2204	Introduction to Multivariable Calculus [1]	3
or MATH 2204H	Introduction to Multivariable Calculus	
MATH 3214	Calculus of Several Variables [1]	3
Select one of the following:		2-3
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
AOE/ESM 2074	Computational Methods [1]	
Subtotal		13-14
Science Courses		
Physics		
PHYS 4714	Introduction to Biophysics [1]	3
Biology		
Select one of the following:		8
Option 1:		
BIOL 1105 & BIOL 1115	Principles of Biology and Principles of Biology Laboratory [1]	
BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory [1]	
Chemistry		
CHEM 1035 & CHEM 1036	General Chemistry and General Chemistry [1]	6
CHEM 1045 & CHEM 1046	General Chemistry Laboratory and General Chemistry Laboratory [1]	2
CHEM 2535 & CHEM 2536	Organic Chemistry and Organic Chemistry [1]	6
CHEM 2545 & CHEM 2546	Organic Chemistry Laboratory and Organic Chemistry Laboratory [1]	2
Statistics		
STAT 3615	Biological Statistics [1]	3
Subtotal		30
Restricted Electives		
Select one of the following:		3
PHYS 3655	Introduction to Astrophysics [1]	
PHYS 3656	Introduction to Astrophysics [1]	
PHYS 4254	Quantum Information Technologies [1]	
PHYS 4264	Quantum Optics and Qubit Processors [1]	
PHYS 4514	Introduction to Nuclear Physics [1]	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 4564	Polymer Physics [1]	
PHYS 4574	Nanotechnology [1]	
PHYS 4614	Optics [1]	

PHYS 4634	Modern Classical Physics [1]	
PHYS 4654	Modern Cosmology [1]	
PHYS 4674	Introduction to General Relativity [1]	
PHYS 4724	Soft Matter Physics [1]	
PHYS 4755	Introduction to Computational Physics [1]	
PHYS 4774	Intro to Physics of Galaxies [1]	
Subtotal		3
Free Electives		
Select 3-4 credits		3-4
Subtotal		3-4
Pathways to General Education		
Pathways Concept 1 - Discourse [3]		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences [3]		
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
Pathways Concept 5 - Quantitative and Computational Thinking [3]		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A) [1]	3
or MATH 2214H	Introduction to Differential Equations	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits. 3 in design + 3 in arts, or 6 in integrated design & arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credit Hours		120

1. Indicates a course with prerequisites or corequisites.
2. MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable[1] and MATH 2214 Introduction to Differential Equations[1] or MATH 2214H Introduction to Differential Equations[1] and PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics[1] are also required of all Physics Majors within the B.A. Degree Program in Physics. They are listed in Pathways to General Education Requirements above.
3. The following course sequence is required of all students majoring in Physics within the B.A. Degree in Physics.

A student will be certified as making satisfactory progress toward the B.A. degree in Physics by satisfying the university's academic eligibility requirements, as well as the following requirements:

- Upon having attempted 60 credit hours, the student will have completed Concept 1 requirements, the Mathematics requirements as well as PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics, PHYS 2325 Seminar for Physics Majors-PHYS 2326 Seminar for Physics Majors, PHYS 2504 Math Methods in Physics, and PHYS 3324 Modern Physics.
- Upon having attempted 45 credit hours, the student must have 2.0 overall and in-major GPAs. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.
- Upon having attempted 72 credit hours, the student will have completed the foreign language requirement by the close of the academic year (spring semester). [College of Science requirement]
- Upon having attempted 96 credit hours, the student will have completed all credits for the Pathways to General Education.

Graduation Requirements

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Department Chair.

Minimum Hours and GPA Required for Graduation

A minimum of 120 credit hours must be completed for graduation. A minimum overall and in-major GPA of 2.0 is required for graduation. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.

Prerequisites and Corequisites

Courses in this major option may have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Accepted Substitutions

- PHYS 3355 Intermediate Mechanics: AOE 3154 Astromechanics **or** ESM 3124 Dynamics II- Analytical and 3-D Motion
- PHYS 3405 Intermediate Electricity and Magnetism: ECE 3105 Electromagnetic Fields
- PHYS 3314 Intermediate Laboratory: AOE 3054 Experimental Methods, **or** ECE 2274 Electronic Networks Laboratory I, **or** ESM 3444 Mechanics Laboratory

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the credits required for graduation. Please consult the Undergraduate Course Catalog for details.

Physics Major with Pre-Law Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
PHYS 2504	Math Methods in Physics [1]	3
PHYS 3314	Intermediate Laboratory	3
PHYS 3324	Modern Physics [1]	4
PHYS 3355	Intermediate Mechanics [1]	3
PHYS 3405	Intermediate Electricity and Magnetism [1]	3
PHYS 3704	Thermal Physics [1]	3
PHYS 4315	Modern Experimental Physics [1]	2
Subtotal		21
Option Required Courses [2]		
PHYS 2325 & PHYS 2326	Seminar for Physics Majors and Seminar for Physics Majors [1]	2
MATH 2114	Introduction to Linear Algebra [1]	3
or MATH 2114H	Introduction to Linear Algebra	
MATH 2204	Introduction to Multivariable Calculus [1]	3
or MATH 2204H	Introduction to Multivariable Calculus	
MATH 3214	Calculus of Several Variables [1]	3
Select one of the following:		2
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
AOE/ESM 2074	Computational Methods [1]	
Subtotal		13
Topical Courses		
COMM 2004	Public Speaking	3
ENGL 3764	Technical Writing [1]	3
STL 2304	Foundations of Science, Technology and Law [1]	3
STL 4304	Intellectual Property Law [1]	3
STL 4314	Current Topics in Science, Technology and Law [1]	3
STL 4324	Global Aspects of Intellectual Property Law [1]	3
Subtotal		18
Restricted Electives		
Select two of the following:		6
PHYS 3655	Introduction to Astrophysics [1]	
PHYS 3656	Introduction to Astrophysics [1]	
PHYS 4254	Quantum Information Technologies [1]	
PHYS 4264	Quantum Optics and Qubit Processors [1]	
PHYS 4514	Introduction to Nuclear Physics [1]	
PHYS 4524	Intro Particle Physics [1]	
PHYS 4554	Introduction to Solid State Physics [1]	
PHYS 4564	Polymer Physics [1]	
PHYS 4574	Nanotechnology [1]	
PHYS 4614	Optics [1]	
PHYS 4634	Modern Classical Physics [1]	
PHYS 4654	Modern Cosmology [1]	
PHYS 4664	Astroparticle Physics	
PHYS 4674	Introduction to General Relativity [1]	
PHYS 4714	Introduction to Biophysics [1]	
PHYS 4724	Soft Matter Physics [1]	
PHYS 4755	Introduction to Computational Physics [1]	
PHYS 4774	Intro to Physics of Galaxies [1]	
Subtotal		6
Free Electives (Students may need to complete less credit hours in this category depending on choices in categories above)		
Select 13 credits		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse [3]		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences [3]		
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics [1]	8
Pathways Concept 5 - Quantitative and Computational Thinking [3]		
MATH 1225	Calculus of a Single Variable (5F)	4
MATH 1226	Calculus of a Single Variable (5F)	4
MATH 2214	Introduction to Differential Equations (5A) [1]	3
or MATH 2214H	Introduction to Differential Equations	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits. 3 in design + 3 in arts, or 6 in integrated design & arts		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		49
Total Credits		**120**

1. Indicates a course with prerequisites or corequisites.
2. MATH 1225 Calculus of a Single Variable-MATH 1226 Calculus of a Single Variable[1] and MATH 2214 Introduction to Differential Equations[1] or MATH 2214H Introduction to Differential Equations[1] and PHYS 2305 Foundations of Physics-PHYS 2306 Foundations of Physics[1] are also required of all Physics Majors within the B.A. Degree Program in Physics. They are listed in Pathways to General Education Requirements above.
3. The following course sequence is required of all students majoring in Physics within the B.A. Degree in Physics.

A student will be certified as making satisfactory progress toward the B.A. degree in Physics by satisfying the university's academic eligibility requirements, as well as the following requirements:

- Upon having attempted 60 credit hours, the student will have completed Concept 1 requirements, the Mathematics requirements as well as PHYS 2305 Foundations of Physics-PHYS 2306

Foundations of Physics, PHYS 2325 Seminar for Physics Majors-PHYS 2326 Seminar for Physics Majors, PHYS 2504 Math Methods in Physics, and PHYS 3324 Modern Physics.

- Upon having attempted 45 credit hours, the student must have 2.0 overall and in-major GPAs. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.
- Upon having attempted 72 credit hours, the student will have completed the foreign language requirement by the close of the academic year (spring semester). [College of Science requirement]
- Upon having attempted 96 credit hours, the student will have completed all credits for the Pathways to General Education.

Graduation Requirements

Outcomes Assessment

Each student is required to participate in the department's Outcomes Assessment procedures as determined by each year's Undergraduate Program Committee and approved by the Department Chair.

Minimum Hours and GPA Required for Graduation

A minimum of 120 credit hours must be completed for graduation. A minimum overall and in-major GPA of 2.0 is required for graduation. All PHYS courses attempted are used in the calculation of the in-major GPA. Non-PHYS courses used as Accepted Substitutions are not used in the calculation of the in-major GPA.

Prerequisites and Corequisites

Courses in this major option have prerequisites or corequisites. Please check with your advisor or consult the Undergraduate Course Catalog.

Acceptable Substitutions

- PHYS 3355 Intermediate Mechanics may be substituted with AOE 3154 Astromechanics, **or** ESM 3124 Dynamics II- Analytical and 3-D Motion
- PHYS 3405 Intermediate Electricity and Magnetism may be substituted with ECE 3105 Electromagnetic Fields
- PHYS 3314 Intermediate Laboratory may be substituted with AOE 3054 Experimental Methods, **or** ECE 2274 Electronic Networks Laboratory I, **or** ESM 3444 Mechanics Laboratory

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six credits of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the credits required for graduation. Please consult the Undergraduate Course Catalog for details.

Psychology

Our Website (http://www.psyc.vt.edu)

Overview

The Department of Psychology offers an undergraduate program leading to the B.S. To graduate with a major in psychology, the undergraduate student must complete the Pathways to General Education requirements, plus the following departmental requirements (please see https://support.psyc.vt.edu/undergrads/advising (https://support.psyc.vt.edu/undergrads/advising/) for more specific details): A minimum of 28 hours of psychology including PSYC 1004 Introductory Psychology, PSYC 1094 Principles of Psychological Research, and three 4000-level courses, at least one with laboratory (PSYC 4964 Field Study, PSYC 4974 Independent Study, and PSYC 4994 Undergraduate Research are not counted as 4000-level courses for purposes of this requirement).

Successful completion of one year of introductory science sequence with corequisite labs (courses can come from biological sciences, chemistry, geosciences, or physics).

Successful completion of one course in Exploring Data, and one course in Exploring Human Diversity.

To graduate with a minor in psychology, the undergraduate student must complete 18 hours of psychology including PSYC 1004 Introductory Psychology, PSYC 1094 Principles of Psychological Research, and two courses at the 3000-level or above (PSYC 2964 Field Study and PSYC 4964 Field Study may not be used toward the psychology minor).

To graduate with a minor in psychology, the undergraduate student must complete 18 hours of psychology including one 4000-level course. (PSYC 2964 Field Study and PSYC 4964 Field Study may not be used toward the psychology minor.)

The department sponsors a chapter of Psi Chi, the national psychology honor society, and the Psychology Club. Information about these and other activities is available at the Academic Advising Center Office (109 Williams Hall) in the Department of Psychology.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education) (see "Academics (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Psychology can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

- Psychology Major (p. 1347)

Chair: Roseanne J. Foti
University Distinguished Professor: T. H. Ollendick
Alumni Distinguished Professor: E. S. Geller
Professors: M. A. Bell, W. K. Bickel, J. W. Finney, R. T. Jones, J. Kim-Spoon, and A. Scarpa
Associate Professors: D. K. Axsom, P. Chiu, R. A. Diana, B. King-Casas, R. J. Foti, B. H. Friedman, D. W. Harrison, N. M. A. Hauenstein, R. K. Pannenton, and J. A. Richey
Assistant Professors: R. Breaux, C. Calderwood, J. I. Hernandez, T-H. Lee, C. McDonnell, and K. Stanton
Clinical Associate Professor: L. D. Cooper
Collegiate Assistant Professor: A. Pittarello
Senior Instructor: K. A. Hoffman

Instructor: V. Diaz
Affiliated Faculty: D. L. Brinberg, Y. Chen, W. D. Crews, E. Feuerbacher, M. Koffarnus, and D. G. Tatar
Undergraduate Professional Advisors: Courtney Glass and Christina Minford (psycadvising@vt.edu)
Career Advisor: Kurt Hoffman (psycadvising@vt.edu)

Undergraduate Course Descriptions (PSYC)

PSYC 1004 - Introductory Psychology (3 credits)
The scientific study of behavior, with a focus on behavioral research methods, analysis, theoretical interpretations, and applications. Survey of brain structures and their functions, sensory mechanisms, developmental processes, classical and operant conditioning, social processes and cultural norms, approaches to psychotherapy, stress and coping, and applications of psychological science.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 1024 - Pathways Through and Beyond the Psychology Major (2 credits)
First Year Experience course introducing students to the psychology major. Discussion of university resources designed to promote student success. Emphasis on career exploration, and finding relevant research and field experiences outside the classroom.
Instructional Contact Hours: (2 Lec, 2 Crd)

PSYC 1094 - Principles of Psychological Research (3 credits)
Philosophical foundation and ethical issues in psychological research. Research design and methodology. Analytic approaches to developing, understanding, interpreting psychological data.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 1524 - Language and the Mind (3 credits)
Examination of what is unique about human language and the evidence that language affects thought. Investigation of how listeners categorize sounds, parse sentences, and access meaning. Examination of what brain damage and speech errors reveal about language in the brain and mind.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 1524

PSYC 2014 - Psychology of Social Interventions (3 credits)
An introduction to the psychological science that underlies behavioral interventions in non-clinical settings. Theories, methods, and applications as they relate to diverse domains such as health, education, prejudice reduction, and the environment. Methodological issues relating to intervention research in psychological science; understanding and limiting possible sources of bias. Relevance and limitations of psychological science for related public policy.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2024 - Psychology Transfer Student Course (1 credit)
First Year Experience course introducing transfer students to the psychology major. Discussion of university resources designed to promote the successful transition from another school to Virginia Tech. Emphasis on career exploration, professional development, and finding relevant research and field experiences outside the classroom.
Instructional Contact Hours: (1 Lec, 1 Crd)

PSYC 2034 - Developmental Psychology (3 credits)
Basic principles of human psychological development from the prenatal period through old age. Interactions between biological and environmental influences on the developing individual. Research methods in developmental science. Cultural influence on parenting practices, identity formation, and attitudes toward the elderly. Survey of recent literature within the areas of perceptual, cognitive, neurobiological, social, and emotional development.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2044 - Psychology of Learning (3 credits)
Survey of fundamental concepts, phenomena, and principles of learning, such as reinforcement/punishment, classical conditioning, and cognitive explanations of retention/forgetting. Traditional learning research, with particular emphasis on methodology and ethical considerations. The behaviorist perspective, and neurobiological and cognitive approaches to understanding learning. The ethical and responsible use of animal models in learning research, and practical applications of learning theory.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2054 - Psychology of Personality (3 credits)
Study of human personality and psychological adjustment: theory and research. Behavioral, cognitive, humanistic, and environmental determinants of personality. Psychological adjustment and personality development.
Prerequisite(s): PSYC 2004 or PSYC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2064 - Introduction to Neuroscience of Behavior (3 credits)
Introduction to biological factors that produce behavior. Neuroanatomy and neurophysiology. The development of the nervous system, and neuroplasticity. Basic neural processes involved in interpreting information, and making decisions. Conducting neuroscience research, and evaluating neuroscience-related claims in the popular media. The ethical and responsible use of nonhuman animal subjects; the ethical application of research findings in neuroscience to current problems such as psychopathy and neurodegenerative disease.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2074 - Animal Behavior (3 credits)
Study of animal behavior: Comparative psychology and ethology, behavioral genetics, evolution of behavior, ecological aspects of behavior, predation, reproduction, and parental care. Some consideration is given to the relevance of animal behavior to human behavior.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2084 - Social Psychology (3 credits)
Introduction to the social behavior of the individual and the group: social perception and forming judgements of others, attitude formation and change, interpersonal attraction, applied psychology. Cultural influences on attitudes toward diversity, prosocial behavior, prejudice, and aggression and conflict. Application of psychological theories and research to address current social problems.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PSYC 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 3014 - Abnormal Psychology (3 credits)
Survey of various types of psychological disorders and of contrasting theoretical views and representative research on the etiology and prognosis of these disorders. Using the Diagnostic and Statistical Manual (DSM-5) to diagnose psychopathologies accurately. Ethical issues pertaining to clinical practice.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3024 - Human Behaviors and Natural Environments (3 credits)
Survey of the effects of natural and human-made environments on health and well-being. Historical changes in human-environment relations. Utilizing psychological research methods to investigate the possible impacts of urbanization on human health and well-being. The impacts of culture, region, and socioeconomics on how we utilize our environments, and our ability to change them. Research pertaining to our relationship with nature, use of natural resources, and strategies to encourage behaviors promoting environmental sustainability.
Prerequisite(s): PSYC 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3034 - Psychological Disorders of Children (3 credits)
An examination of theory, research, and practice as related to the assessment, treatment, and prevention of psychological disorders of children. Special emphasis on the understanding of child behavior disorders from a developmental, clinical-experimental point of view.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and PSYC 3014
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3054 - Health Psychology (3 credits)
Major theories, strategies, and methods for understanding psychological contributions to health and disease; psychological approaches to the treatment and prevention of disease and unintentional injuries, and health and safety promotion.
Prerequisite(s): PSYC 2004 or PSYC 1004
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3094 - Advanced Research Methods in Psychological Science (3 credits)
Advanced research and analytical methods. Emphasis on methods for specific research and/or practical questions, critical evaluation of research publications. Extended coverage of design and analysis principles and skills, selection and completion of appropriate statistical tests for given data sets. Student-driven empirical report including literature review, methods, analysis, interpretation, and implications for future research. PSYC majors only.
Prerequisite(s): (PSYC 1094 or PSYC 2094) or STAT 3604 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4014 - History and Systems in Psychology (3 credits)
Overview of modern theories in psychology by consideration of current historical controversies. Traces roots of psychology in natural and social sciences. Considers the diversity of psychological study and the future of psychology. Senior standing in psychology required for undergraduate credit. Graduate standing required for graduate credit.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4024 - Industrial and Organizational Psychology (3 credits)
Overview of psychological theories, research findings, and methods relevant to studying the behavior of individuals in organizations. Topics covered may include prediction of job performance, personnel testing, training and development, and leadership.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4034 - Special Topics in Developmental Psychology (3 credits)
Rotating topics in the development of perceptual, cognitive, and socioemotional functioning throughout the life-span. In-depth, critical evaluation of current research literature and theory within various major age-spans. Developmental research methods, and research ethics. Cross cultural and contextual effects on development. May be repeated with different topics for a maximum of 6 credit hours.
Prerequisite(s): PSYC 1004 and PSYC 2034 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

PSYC 4044 - Advanced Learning (3 credits)
Critical analysis of basic paradigms of Pavlovian and Instrumental Conditioning with emphasis on general theories of learning and issues involved in cognition, reinforcement, and memory.
Prerequisite(s): PSYC 1004 and PSYC 2044 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4054 - Personality Research (3 credits)
Research techniques used in contemporary personality psychology: case histories, correlational methods, experimentation, archival studies, and psychobiography.
Prerequisite(s): PSYC 1004 and PSYC 2054 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4064 - Physiological Psychology (3 credits)
Presentation of concepts important for the study of neuroscience and behavior with a special emphasis on the classic topics of physiological psychology: brain-behavior relations, sensory integration, physiological correlates of motivation and emotion.
Prerequisite(s): PSYC 1004 and (PSYC 2064 or NEUR 2025) and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4074 - Sensation and Perception (3 credits)
Overview of sensory and perceptual systems and their integration in influencing behavior. Emphasis on sensory receptor characteristics, neural structure, psychophysical data, perceptual phenomena and issues, theories about the human perceptual process.
Prerequisite(s): PSYC 1004 and (PSYC 2064 or NEUR 2025) and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4084 - Advanced Social Psychology (3 credits)
Examines social behavior from four major theoretical orientations: reinforcement, field theory, cognitive, and role theory. Topics may include social learning, social exchange theories, group processes, attitude, and person perception.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and PSYC 2084
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4094 - Theory of Psychological Measurement (3 credits)
Theory of psychological measurement and techniques used to develop and evaluate psychological measures. Coverage of standardization, measurement scales, reliability, validity, score transformations, composite scores, weighted scores, and test construction.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4114 - Cognitive Psychology (3 credits)
An experimentally-oriented survey of human cognitive processes which include attention, memory, and decision making. Role of individual difference variables in each area.
Prerequisite(s): PSYC 1004 and PSYC 2044 and (PSYC 1094 or HD 3014 or SOC 3204)
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4134 - Language Development (3 credits)
Survey of theories, mechanisms, and processes in human language development. Empirical overview of phonology, semantics, syntax, and pragmatics. Developmental trajectories of mono- and multilingual children. Cultural constraints on language. Perception of language and production of language, in typical and atypical subpopulations (e.g., hearing impairment). Junior/Senior Standing.
Prerequisite(s): PSYC 1004 or PSYC 2004
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ENGL 4134

PSYC 4154 - Bilingual Development and Cognition (3 credits)
Survey of the process of language acquisition for children exposed to two languages during their early development. Cognitive development in children growing up in bilingual homes. Exploration of the effects of family factors, social experiences, cultural language norms, and language policies on bilingual children and adults in the current transnational environment of immigration and globalization. The effects of heritage language preservation on cultural identity and issues of equity related to linguistic discrimination in the United States.
Prerequisite(s): PSYC 1004 or PSYC 1524 or ENGL 1524 or ENGL 1504 or HD 1004
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 7 Identity & Equity in U.S., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4184 - The Science of Giving (3 credits)
Overview of the science of giving, altruism, helping, cooperation, and prosocial behaviors and decision making. Exploration of the personality contextual, cognitive, and affective factors that move people to help others in need. Application of psychological and behavioral principles necessary to craft interventions such as nudges to increase giving with emphasis on public policy. Methodological issues related to laboratory and field experiments. Ethical considerations in persuasion and influence.
Prerequisite(s): PSYC 1094 or HD 3014 or SOC 3204
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4184

PSYC 4194 - Predicting Social Behavior (3 credits)
Overview of the process of predicting human choices, preferences, and actions in social contexts. Applications of measurement theory to data preparation, formatting, and scaling. Implications of psychological biases for data transformation and cleaning. Theory-guided predictor variable selection and development. Applications of machine learning to social settings. Evaluating prediction quality, bias, and generalizability. Developing predictive models in software. Ethical and societal implications of predicting human behavior.
Prerequisite(s): PSYC 1004 and (PSYC 1094 or HD 3014 or SOC 3204) and (STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or BIT 2405)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BDS 4194

PSYC 4214 - Cognitive Psychology Laboratory (1 credit)
Design, operation, and analysis of experiments to study human cognitive processes (e.g., attention, memory, and decision-making).
Corequisite(s): PSYC 4114
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4234 - Laboratory in Developmental Psychology (1 credit)
Research design and implementation in the study of perceptual and motor development, language development, cognitive development, and social development.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and PSYC 2034
Corequisite(s): PSYC 4034
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4244 - Laboratory in Advanced Learning (1 credit)
Experimental techniques for studying the development, maintenance, and retention of behavior change in humans and animals. Laboratory exercises in Pavlovian and Instrumental Conditioning, verbal learning and memory.
Corequisite(s): PSYC 4044
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4254 - Personality Research Laboratory (1 credit)
Laboratory course in personality research techniques. Emphasis on experimental, archival, questionnaire, and psychobiographical approaches.
Corequisite(s): PSYC 4054
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4264 - Laboratory in Physiological Psychology (1 credit)
Experimental techniques in the area of physiological psychology including: handling and care of laboratory animals, anesthetic and surgical techniques, and measurement of physiological variables.
Corequisite(s): PSYC 4064
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4274 - Laboratory in Sensation and Perception (1 credit)
Overview of the major experimental techniques and phenomena of sensation and perception. Emphasis on psychophysical methods, signal detection, dark adaptation, perceptual illusions.
Corequisite(s): PSYC 4074
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4284 - Laboratory in Social Psychology (1 credit)
Design, performance, and analysis of experiments in social psychology. Various methodologies used in social research (e.g., laboratory experimentation, field observations) will be studied through actual performance of experiments.
Corequisite(s): PSYC 4084
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4294 - Laboratory in Psychological Measurement (1 credit)
Design and implementation of psychological assessment devices including issues of test construction, reliability, validity, standardizing, and detecting test bias.
Prerequisite(s): (PSYC 2004 or PSYC 1004) and (PSYC 2094 or PSYC 1094) and (STAT 2004 or STAT 3604 or STAT 2405)
Corequisite(s): PSYC 4094
Instructional Contact Hours: (3 Lab, 1 Crd)

PSYC 4354 - Senior Seminar (3 credits)
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4364 - Senior Seminar (3 credits)
For Psyc majors. Intended to provide in-depth coverage and discussion of a small set of topics selected by members of the seminar.
Instructional Contact Hours: (3 Lec, 3 Crd)

PSYC 4454 - Neuroeconomics (3 credits)
Neural processes related to reward, learning, reflection, delay of gratification, and social interaction. Clinical uses of neuroeconomics research techniques. Implications of neuroeconomics, policy, law and business.
Prerequisite(s): NEUR 2026 or ECON 3104
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: ECON 4454, NEUR 4454

PSYC 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

PSYC 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PSYC 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Psychology Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
Introductory Requirements		
PSYC 1004	Introductory Psychology	3
PSYC 1094	Principles of Psychological Research [1]	3
Foundations of Psychology		
Select two of the following:		6
PSYC 2034	Developmental Psychology	
PSYC 2044	Psychology of Learning	
PSYC 2064	Introduction to Neuroscience of Behavior	
PSYC 2084	Social Psychology	
4000-Level Lecture Course with Co-Requisite One-Credit Laboratory		
Select one of the following:		4
Development Lecture/Lab		
PSYC 4034 & PSYC 4234	Special Topics in Developmental Psychology and Laboratory in Developmental Psychology	
Cognition and Learning Lecture/Lab		
PSYC 4044 & PSYC 4244	Advanced Learning and Laboratory in Advanced Learning	
PSYC 4114 & PSYC 4214	Cognitive Psychology and Cognitive Psychology Laboratory	
Biological Lecture/Lab		
PSYC 4064 & PSYC 4264	Physiological Psychology and Laboratory in Physiological Psychology	
PSYC 4074 & PSYC 4274	Sensation and Perception and Laboratory in Sensation and Perception	
Interpersonal Psychology Lecture/Lab		
PSYC 4084 & PSYC 4284	Advanced Social Psychology and Laboratory in Social Psychology	
Industrial/Organizational and Workplace Psychology Lecture Lab		
PSYC 4054 & PSYC 4254	Personality Research and Personality Research Laboratory	
PSYC 4094 & PSYC 4294	Theory of Psychological Measurement and Laboratory in Psychological Measurement	
Psychology Special Topics Senior Seminar		
PSYC 4354/4364	Senior Seminar	3
Subtotal		19
Additional Course Requirements		
Electives within Psychology [2, 3, 4, 5]		
Select three of the following (9 credits, at least 3 credits must be at the 4000 level):		9
Developmental and Focus		

PSYC/ENGL 1524	Language and the Mind
PSYC 2034	Developmental Psychology
PSYC/EDEP 3154	
PSYC 4034	Special Topics in Developmental Psychology
PSYC/ENGL 4134	Language Development
PSYC 4154	Bilingual Development and Cognition
Cognition and Learning Focus	
PSYC 2044	Psychology of Learning
PSYC 3024	Human Behaviors and Natural Environments
PSYC 4044	Advanced Learning
PSYC 4114	Cognitive Psychology
Biological Focus	
PSYC 2064	Introduction to Neuroscience of Behavior
PSYC 2074	Animal Behavior
PSYC 3054	Health Psychology
PSYC 4064	Physiological Psychology
PSYC 4074	Sensation and Perception
PSYC/ECON/NEUR 4454	Neuroeconomics
Interpersonal Focus	
PSYC 2084	Social Psychology
PSYC 4084	Advanced Social Psychology
PSYC 4184	The Science of Giving
PSYC/BDS 4194	Predicting Social Behavior
Industrial/Organizational and Workplace Psychology Focus	
PSYC 2054	Psychology of Personality
PSYC 4024	Industrial and Organizational Psychology
PSYC 4054	Personality Research
PSYC 4094	Theory of Psychological Measurement
Clinical Focus	
PSYC 2014	Psychology of Social Interventions
PSYC 3014	Psychopathology
PSYC 3034	Psychological Disorders of Children
Other Electives	
PSYC 3094	Advanced Research Methods in Psychological Science
PSYC 4014	History and Systems in Psychology
PSYC 2974	Independent Study
PSYC 2994	Undergraduate Research
PSYC 4974	Independent Study
PSYC 4994	Undergraduate Research
First Year Experience	
PSYC 1024	Pathways Through and Beyond the Psychology Major [6] 2
Science Requirement for Psychology	
Beyond Pathways General Education requirements. Select one year of an introductory science sequence with labs, from a sequence or cluster listed below; you must complete a sequence or cluster within the same department. 8	
BIOL 1105 & BIOL 1115 & BIOL 1106 & BIOL 1116	Principles of Biology and Principles of Biology Laboratory and Principles of Biology and Principles of Biology Laboratory
BMSP 2135 & BMSP 2145 & BMSP 2136 & BMSP 2146	Human Anatomy & Physiology and Human Anatomy and Physiology Laboratory and Human Anatomy and Physiology and Human Anatomy and Physiology Laboratory
GEOS 1004 & GEOS 1104 & GEOS 1024 & GEOS 1124	Earth Science: Our Past, Present, and Future and Introduction to Earth Sciences Laboratory and Earth Resources, Society, and Environment and Earth Resources, Society and Environment Laboratory
CHEM 1015 & CHEM 1025 & CHEM 1016 & CHEM 1026	Chemistry in Context and Introduction to Chemistry Laboratory and Chemistry in Context and Introduction to Chemistry Laboratory
CHEM 1035 & CHEM 1045 & CHEM 1036 & CHEM 1046	General Chemistry and General Chemistry Laboratory and General Chemistry and General Chemistry Laboratory
PHYS 1055 & PHYS 1155 & PHYS 1056 & PHYS 1156	Introduction to Astronomy and Astronomy Laboratory and Introduction to Astronomy and Astronomy Laboratory
PHYS 2205 & PHYS 2215 & PHYS 2206 & PHYS 2216	General Physics and General Physics Laboratory and General Physics and General Physics Laboratory
PHYS 2305 & PHYS 2306	Foundations of Physics and Foundations of Physics
Exploring Data [7]	
Select one of the following: 3	
ACIS 1504	Introduction to Business Analytics and Business Intelligence
or BDS 2005	Fundamentals of Behavioral Decision Science
or CS 1014	Introduction to Computational Thinking
or ENGL 203	Analyzing the Sounds of Language
or HD 3024	Community Analytics
or SOC 2104	Quantitative Approaches to Community Research
or SOC 2604	Introduction to Data in Social Context
or PHIL 150	Critical Thinking
or STAT 101	Data in Our Lives
or STAT 200	Introductory Statistics
or STAT 361	Biological Statistics
Exploring Human Diversity	
Select one of the following: 3	
AFST 1714	Introduction to African American Studies
or AFST 1814	Introduction to African Studies
or AFST 2454	Race and Racism
or AFST 2734	The Black Woman in the U.S.
or AINS 1104	Introduction to American Indian Studies
or APS 1704	Introduction to Appalachian Studies
or ECON 1104	Economics of Gender
or EDCI 3024	Issues of Schooling in the United States
or EDCI 3144	Education of Exceptional Learners

or HD 2314	Human Sexuality	
or HD 1134	Introduction to Disabilities Studies	
or PSVP 2044	Peace and Violence	
or RLCL 2204	Race and Gender in Religion and Culture	
or SOC 2004	Social Problems	
or SOC 2024	Sociology of Race and Ethnicity	
or SOC 2034	Diversity and Community Engagement	
or SOC 2514	Asian American Experience	
or SOC 3614	Gender and Work in the U.S.	
or WGS 1824	Introduction to Womens and Gender Studies	
Subtotal		25
Pathways to General Education		
See relevant pages in Psychology Student Handbook for further information		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04) [8]		6
Pathways Concept 5 - Quantitative and Computational Thinking		
Select 6 credits from the courses listed below:		6
MATH 1014 & MATH 1025	Precalculus with Transcendental Functions and Elementary Calculus (5F)	
MATH 1025 & MATH 1026	Elementary Calculus and Elementary Calculus (5F)	
MATH 1014 & MATH 1524	Precalculus with Transcendental Functions and Business Calculus (5F)	
MATH 1225 & MATH 1026	Calculus of a Single Variable and Elementary Calculus (5F)	
Select one of the following:		3
STAT 3604	Statistics for Social Science [9]	
or STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		45
Free Electives		
Complete sufficient semester hours of Free Electives to total 120 hours 31 credits of free electives		31
Subtotal		31
Total Credits		**120**

1 PSYC 1094 Principles of Psychological Research: HD 3014 or SOC 3204

2 No course is repeatable, except PSYC 4034, PSYC 2974, PSYC 2994, PSYC 4974, and PSYC 4994.

3 The categorization scheme, placing courses within different foci, is designed simply to help students identify courses of interest; a number of courses could easily fit within 2 or more categories.

4 Some of these courses have prerequisites. Please consult the Course Timetable and Course Catalog.

5 Any courses counting towards the Psychology major requirements must be taken for a letter grade (A-F).

6 PSYC 1024 Pathways Through and Beyond the Psychology Major: Any of the university-approved First Year Experience courses can substitute for PSYC 1024

7 STAT 2004 Introductory Statistics will not count for credit if taken after any Statistics course with a higher number.

8 Only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected to fulfill this requirement.

9 PATHWAYS GENERAL EDUCATION CONCEPT 5 advanced/applied: STAT 3005

The following are to be used to assess satisfactory progress toward a B.S. degree in Psychology:

- Upon having attempted 30 semester hours, students must have completed 12 semester credits that apply to the Pathways to General Education, PSYC 1004 Introductory Psychology and have an overall GPA of 2.00.
- Upon having attempted 72 semester hours, students must have completed 24 semester credits that apply to the Pathways to General Education and have an overall GPA of 2.00. Also, PSYC 1004 Introductory Psychology, PSYC 1094 Principles of Psychological Research, and an additional 3 hr. PSYC course.
- Upon having attempted 96 semester credits, students must have completed all Pathways to General Education Courses and have an overall GPA of 2.00.
- To graduate, students must completed 120 semester hours and have an overall GPA of 2.00.

Graduation Requirements

Prerequisites

Some courses listed on this checksheet have prerequisites; please consult the University Course Catalog or check with your advisor.

In-Major GPA

Students must maintain a minimum in-major GPA of 2.0. All courses taken within the Department of Psychology count toward the in-major GPA.

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign

language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Statistics

Our Website (http://www.stat.vt.edu)

Overview

Statistics courses are offered at both the undergraduate and the graduate levels for students preparing for professions in statistics, for students who need statistical tools to engage in scientific research, and for students who want to acquire knowledge of the important concepts of probability and statistical inference.

Statistics courses for graduate students and programs leading to the M.S. and Ph.D. degrees in statistics are described in the Graduate Catalog (https://catalog.vt.edu/graduate/) and in a special bulletin available from the department.

Bachelor of Science in Statistics

All statistics majors are required to own specified personal computers and software. Consult the department for details.

Internship positions are available in industry and government, offering valuable practical experience. Students participating in such an experience can receive academic credit which will count towards graduation requirements.

Minor in Statistics

Please visit the University Registrar website at http://registrar.vt.edu/graduation-multi-brief/index1.html to view requirements for the minor.

The department reserves the right to withhold credit if a student takes a course, the content of which is partially duplicated in a course already taken (see "Course Duplications" below).

The Statistical Applications and Innovations Group

Associated with the Department, the Statistical Applications and Innovations Group (SAIG) provides assistance for research projects to participating members of the University community and outside organizations. Statistics Department faculty members and students collaborate to design studies, analyze data, and interpret results for Virginia Tech affiliated clients and external clients in business, industry, government, and non-profit organizations. SAIG provides both experiential learning for statistics students and service to the University and beyond. To learn more, visit https://saig.stat.vt.edu/.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the Pathways to General Education (https://www.pathways.prov.vt.edu/about/concepts.html) and toward the degree.

Satisfactory progress requirements toward the B.S. in Statistics can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Course Duplications

- No credit will be given for STAT 2004 Introductory Statistics if taken with or after any other statistics course, except STAT 2984 Special Study.
- For non-majors, all of the following are partial duplications: STAT 3005 Statistical Methods, STAT 3604 Statistics for Social Science, STAT 3615 Biological Statistics, STAT 4604 Statistical Methods for Engineers, and STAT 4705 Probability and Statistics for Engineers.
- For majors, STAT 4604 Statistical Methods for Engineers and STAT 4705 Probability and Statistics for Engineers may replace STAT 3005 Statistical Methods if taken before becoming a major.
- All the following are partial duplications: STAT 3006 Statistical Methods, STAT 3616 Biological Statistics, and STAT 4706 Probability and Statistics for Engineers.
- No credit will be given for STAT 3704 Statistics for Engineering Applications if taken after any of the following: STAT 3005 Statistical Methods, STAT 3615 Biological Statistics, STAT 4604 Statistical Methods for Engineers, and STAT 4705 Probability and Statistics for Engineers.
- BIT 2405 Introduction to Business Statistics, Analytics, and Modeling may not be used as a substitute for credit as a statistics course unless the student was officially registered as a Business major at the time BIT 2405 Introduction to Business Statistics, Analytics, and Modeling was taken.

Computer Literacy

Many statistics courses involve the use of statistics software, primarily MINITAB, SAS, JMP or R. Experience with the software is not expected, but students should have familiarity with either the Windows or Macintosh operating system and have access to a computer.

Course Projects

Many of the upper-division courses include a project, generally to be completed in small groups. These projects are designed to give students the kind of insight and experience in realistic statistical practice that cannot be obtained in classroom lectures or short-term homework assignments.

- Statistics Majors with Statistical Data Science Option (p. 1354)
- Statistics Majors with Statistical Methods and Theory Option (p. 1356)

Head: D. Higdon
Professors: P. Du, M. Ferreira, R. Fricker, R. Gramacy, F. Guo, D. Higdon, Y. Hong, I. Hoeschelle, I. Kim, J. Morgan, E. Smith, G. Vining.
Associate Professors: X. Deng, C. Franck, P, L. House, L. Johnson, Leman, G. Terrell, X. Wu, H. Zhu
Professor of Practice: A. Hanlon, J. Van Mullekom, T. Woteki
Associate Professor of Practice: F. Faltin, A. Patterson
Assistant Professors: M. Liu, X. Xing, and J. Datta
Collegiate Associate Professors: A. Driscoll, J. Robertson Evia
Collegiate Assistant Professors: C. Lucero, H. Mahmoud, F. McCarty, Sierra Merkes
Research Professor: L. Freeman
Research Associate Professor: A. Tegge
Instructors: J. Loda, J. Russell, H. Tavera, Z. Zhang

Undergraduate Course Descriptions (STAT)

STAT 1004 - The First Year Experience in Learning from Data (2 credits)
Introduction to the field of statistics and aspects of college life for first year students. Topics included: history of the statistics; key roles of statisticians in field, such as actuarial sciences, pharmaceutical, medical, and bioinformatics industries, governmental agencies, academia; fundamental principles of statistical fields of study and applications; exploring data sets; and aspects of college life for first-year students.
Instructional Contact Hours: (2 Lec, 2 Crd)

STAT 1014 - Data in Our Lives (3 credits)
Develop and practice the process of thinking critically with data in the context of real world problems. Import, manage, summarize, and visualize data using programmable, statistical software. Make data discoveries, make decisions, generate hypotheses, and/or communicate findings in data. Consider laws of probability and personal biases to weigh decisions. Recognize ethical issues and vulnerabilities in analyses when learning from data and extrapolating to large populations.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2004 - Introductory Statistics (3 credits)
Fundamental concepts and methods of statistics with emphasis on interpretation of statistical arguments and statistical reasoning. Using modern, accessible statistical software and technology, an introduction to design of experiments (including data collection), data analysis, data visualization, correlation and regression, concepts of probability theory, sampling errors, confidence intervals, and hypothesis tests. Include real-world applications to develop problem-solving skills and consider ethical implications within the context of learning from data. No credit will be given for 2004 if taken with or after any other statistics course, except STAT 2984.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 2094 - Basic R for Statistics (1 credit)
Introduction to R/RStudio programming techniques with an emphasis on basic statistical visualizations, descriptive and summary statistics, and elementary inferential statistics. Topics include data types, data structures, importing/exporting, and manipulating datasets, functions, packages, and RMarkdown.
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 2274 - Basic Python For Statistics (1 credit)
Use of Python code and libraries (SciPy and NumPy) to support basic statistical tasks, create graphical displays, and perform statistical inference and hypothesis tests to evaluate datasets. Use of editors and AI to generate Python code.
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 2964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

STAT 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 2984O - Special Study (1-19 credits)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv.
Instructional Contact Hours: Variable credit course

STAT 3005 - Statistical Methods (3 credits)
3005: Basic statistical methodology: exploratory data techniques, estimation, inference, comparative analysis by parametric, nonparametric, and robust procedures. Analysis of variance (one-way), multiple comparisons, and categorical data. Includes real-world examples. Develops problem-solving skills and ethical reasoning within the context of learning from data. 3006: Analysis of variance, simple and multiple, linear and nonlinear regression, analysis of covariance. Use of MINITAB. STAT 3005 duplicates STAT 3615 and STAT 4604, only one may be taken for credit. STAT 3006 duplicates STAT 3616, STAT 4604 and STAT 4706, only one may be taken for credit.
Prerequisite(s): MATH 1225
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3006 - Statistical Methods (3 credits)
3005: Basic statistical methodology: exploratory data techniques, estimation, inference, comparative analysis by parametric, nonparametric, and robust procedures. Analysis of variance (one-way), multiple comparisons, and categorical data. Includes real-world examples. Develops problem-solving skills and ethical reasoning within the context of learning from data. 3006: Analysis of variance, simple and multiple, linear and nonlinear regression, analysis of covariance. Use of MINITAB. STAT 3005 duplicates STAT 3615 and STAT 4604, only one may be taken for credit. STAT 3006 duplicates STAT 3616, STAT 4604 and STAT 4706, only one may be taken for credit.
Prerequisite(s): STAT 3005 or STAT 4705 or CMDA 2005
Corequisite(s): MATH 1206 or MATH 1226 for 3005.
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3094 - SAS Programming (3 credits)
Introduction to basic programming techniques: creating DATA and PROC statements, libraries, functions, programming syntax and formats. Other topics include loops, SAS Macros and PROC IML. Emphasis is placed on using these tools for statistical analyses. The pre-requisite may be substituted for an equivalent course.
Prerequisite(s): STAT 3005 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3104 - Probability and Distributions (3 credits)
Probability theory, including set theoretic and combinatorial concepts; in-depth treatment of discrete random variables and distributions, with some introduction to continuous random variables; introduction to estimation and hypothesis testing.
Prerequisite(s): (MATH 1226 or MATH 1026) and (STAT 3005 or STAT 3615 or STAT 4705 or CMDA 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3204 - Data Visualization (3 credits)
Using quantitative and qualitative thinking to develop a working knowledge of data visualization considerations, methods and techniques that lead to: understanding the audience(s); creating ethical data stories; data visualization as a method of storytelling; ethical and appropriate data exploration, manipulation, and cleaning; design considerations; types of visualizations; tools and resources for creating visualizations.
Prerequisite(s): (STAT 1014 or STAT 2004 or STAT 3005 or STAT 3604 or STAT 3615 or STAT 4705 or STAT 4706 or STAT 4714 or CMDA 2005 or CMDA 2014) and (COMM 1016 or ENGL 1105)
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3274 - Introduction to Sports Analytics Research (3 credits)
Introduction to sports analytics, sources of sports analytics data and data collection methods, visualization techniques, game performance statistics, inferential statistics and predictive modeling techniques for sports data. Role and applications of data analytics in the sports industry.
Prerequisite(s): CMDA 2006 or STAT 3006
Corequisite(s): CMDA 3654 or CS 3654 or STAT 3654.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3274

STAT 3504 - Nonparametric Statistics (3 credits)
Statistical methodology based on ranks, empirical distributions, and runs. One and two sample tests, ANOVA, correlation, goodness of fit, and rank regression, R-estimates and confidence intervals. Comparisons with classical parametric methods. Emphasis on assumptions and interpretation.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4604 or STAT 4706 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3604 - Statistics for Social Science (3 credits)
Statistical methods for nominal, ordinal, and interval levels of measurement. Topics include descriptive statistics, elements of probability, discrete and continuous distributions, one and two sample tests, measures of association. Emphasis on comparison of methods and interpretations at different measurement levels. Includes real-world applications to develop problem-solving skills and ethical reasoning within the context of learning from data.
Prerequisite(s): MATH 1014 or MATH 1025 or MATH 1214 or MATH 1225 or MATH 1524
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3615 - Biological Statistics (3 credits)
Descriptive and inferential statistics in a biological context with real-world examples. In analytical contexts, develops problem-solving skills and ethical reasoning. 3615: Fundamental principles, one- and two-sample parametric inference, simple linear regression, frequency data. 3616: One- and two-way ANOVA, multiple regression, correlation, nonparametrics, using a computer package. STAT 3615 partially duplicates STAT 3005 and STAT 4604, only one may be taken for credit. STAT 3616 partially duplicates STAT 3006, 4604 and 4706, only one may be taken for credit.
Prerequisite(s): MATH 1225 or MATH 1025 or MATH 1524 or ISC 1105
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3616 - Biological Statistics (3 credits)
Descriptive and inferential statistics in a biological context with real-world examples. In analytical contexts, develops problem-solving skills and ethical reasoning. 3615: Fundamental principles, one- and two-sample parametric inference, simple linear regression, frequency data. 3616: One- and two-way ANOVA, multiple regression, correlation, nonparametrics, using a computer package. STAT 3615 partially duplicates STAT 3005 and STAT 4604, only one may be taken for credit. STAT 3616 partially duplicates STAT 3006, 4604 and 4706, only one may be taken for credit.
Prerequisite(s): STAT 3615
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 3654 - Introductory Data Analytics and Visualization (3 credits)
Basic principles and techniques in data analytics; methods for the collection of, storing, accessing, and manipulating standard-size and large datasets; data visualization; and identifying sources of bias.
Prerequisite(s): (CS 1114 or CS 1044 or CS 1054 or CS 1064) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3006 or STAT 4105 or STAT 4705 or STAT 4714 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 3654, CS 3654

STAT 3704 - Statistics for Engineering Applications (2 credits)
Introduction to statistical methodology with emphasis on engineering experimentation: probability distributions, estimation, hypothesis testing, regression, and analysis of variance. Only one of the courses 3704, 4604, 4705, and 4714 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (2 Lec, 2 Crd)

STAT 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4004 - Methods of Statistical Computing (3 credits)
Computationally intensive computer methods used in statistical analyses. Statistical univariate and multivariate graphics; resampling methods including bootstrap estimation and hypothesis testing and simulations; classification and regression trees; scatterplot smoothing and splines.
Prerequisite(s): STAT 4105 and STAT 4214
Instructional Contact Hours: (4 Lec, 3 Crd)

STAT 4024 - Communication in Statistical Collaborations (3 credits)
Theory and examples of effective communication in the context of statistical collaborations. Practice developing the communication skills necessary to be effective statisticians using peer feedback and self-reflection. Topics include helping scientists answer their research questions, writing about and presenting statistical concepts to a non-statistical audience, and managing an effective statistical collaboration meeting. Senior standing in the Department of Statistics.
Prerequisite(s): STAT 4214 and STAT 4204
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4094 - Introduction to Programming in R (1 credit)
Introduction to R programming techniques with an emphasis on statistical analyses. Topics include: data objects, loops, importing/exporting datasets, graphics, functions, t-tests, ANOVA, linear regression, nonparametric tests, and logistic regression.
Prerequisite(s): STAT 3615 or STAT 3005
Instructional Contact Hours: (1 Lec, 1 Crd)

STAT 4105 - Theoretical Statistics (3 credits)
4105: Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics. 4106: Convergence of sequences of random variables; central limit theorem; methods of estimation; hypothesis testing; linear models; analysis of variance. STAT 4105 partially duplicates STAT 4705, STAT 4714, and STAT 4724, only one may be taken for credit.
Prerequisite(s): (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and STAT 3104
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4106 - Theoretical Statistics (3 credits)
4105: Probability theory, counting techniques, conditional probability; random variables, moments; moment generating functions; multivariate distributions; transformations of random variables; order statistics. 4106: Convergence of sequences of random variables; central limit theorem; methods of estimation; hypothesis testing; linear models; analysis of variance. STAT 4105 partially duplicates STAT 4705, STAT 4714, and STAT 4724, only one may be taken for credit.
Prerequisite(s): STAT 4105
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4204 - Experimental Designs (3 credits)
Fundamental principles of designing and analyzing experiments with application to problems in various subject matter areas. Discussion of completely randomized, randomized complete block, and Latin square designs, analysis of covariance, split--plot designs, factorial and fractional designs, incomplete block designs.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5605 or STAT 5615 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4214 - Methods of Regression Analysis (3 credits)
Multiple regression including variable selection procedures; detection and effects of multicollinearity; identification and effects of influential observations; residual analysis; use of transformations. Non-linear regression, the use of indicator variables, and logistic regression. Use of SAS.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5606 or STAT 5616 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4274 - Sports Analytics Statistical Research (3 credits)
Statistical analysis of sports data. Game performance statistics and expected scores. Analysis of player performance, player tracking, team performance, and sports betting. Bayesian methods and prediction models applied to sports data. Decision-making. Assessing sports analytics research and literature.
Prerequisite(s): (STAT 4214 and STAT 4444) or (CMDA 4654 or CS 4654 or STAT 4654) or (STAT 3274 or CMDA 3274)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4274

STAT 4364 - Introduction to Statistical Genomics (3 credits)
Statistical methods for bioinformatics and genetic studies, with an emphasis on statistical analysis, assumptions, and problem-solving. Topics include: commonly used statistical methods for gene identification, association mapping and other related problems. Focus on statistical tools for gene expression studies and association studies, multiple comparison procedures, likelihood inference and preparation for advanced study in the areas of bioinformatics and statistical genetics.
Prerequisite(s): (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006) and (STAT 3006 or STAT 3616 or STAT 4706 or CMDA 2006)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4444 - Applied Bayesian Statistics (3 credits)
Introduction to Bayesian methodology with emphasis on applied statistical problems: data displaying, prior distribution elicitation, posterior analysis, models for proportions, means and regression.
Prerequisite(s): (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005) and (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006) and STAT 3006 or STAT 3616 or STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4504 - Applied Multivariate Analysis (3 credits)
Non-mathematical study of multivariate analysis. Multivariate analogs of univariate test and estimation procedures. Simultaneous inference procedures. Multivariate analysis of variance, repeated measures, inference for dispersion and association parameters, principal components analysis, discriminate analysis, cluster analysis. Use of SAS.
Prerequisite(s): STAT 3006 or STAT 4706 or CMDA 2006 or STAT 3616
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4514 - Introduction to Categorical Data Analysis (3 credits)
Statistical approaches to analyze categorical data. Probability computation and distribution specification, interval estimation and hypothesis testing, formulating and fitting generalized linear models including logistic and Poisson regression, algorithms used for model fitting, variable selection, and classification trees and supervised learning.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4524 - Sample Survey Methods (3 credits)
Statistical methods for the design and analysis of survey sampling. Fundamental survey designs. Methods of randomization specific to various survey designs. Estimation of population means, proportions, totals, variances, and mean squared errors. Design of questionnaires and organization of a survey.
Prerequisite(s): STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5606 or STAT 5616
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4534 - Applied Statistical Time Series Analysis (3 credits)
Applied course in time series analysis methods. Topics include regression analysis, detecting and address autocorrelation, modeling seasonal or cyclical trends, creating stationary time series, smoothing techniques, forecasting and forecast errors, and fitting autoregressive integrated moving average models.
Prerequisite(s): STAT 3006 or STAT 4104 or STAT 4706 or STAT 4714 or STAT 3616 or BIT 2406 or CMDA 2006
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4584 - Advanced Calculus for Statistics (3 credits)
Introduction to those topics in advanced calculus and linear algebra needed by statistics majors. Infinite sequences and series. Orthogonal matrices, projections, quadratic forms. Extrema of functions of several variables. Multiple integrals, including convolution and nonlinear coordinate changes.
Prerequisite(s): (MATH 1114 or MATH 2114 or MATH 2114H or MATH 2405H) and (MATH 1225) and (MATH 1226) and (MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4604 - Statistical Methods for Engineers (3 credits)
Introduction to statistical methodology with emphasis on engineering applications: probability distributions, estimation, hypothesis testing, regression, analysis of variance, quality control. Only one of the courses 4604, 4705, and 4714 may be taken for credit. STAT 4604 partially duplicates STAT 3005, STAT 3615, STAT 3006, STAT 3616 and STAT 4706. Only one may be taken for credit.
Prerequisite(s): MATH 1226
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4654 - Intermediate Data Analytics and Machine Learning (3 credits)
A technical analytics course. Covers supervised and unsupervised learning strategies, including regression, generalized linear models, regularization, dimension reduction methods, tree-based methods for classification, and clustering. Upper-level analytical methods shown in practice: e.g., advanced naive Bayes and neural networks.
Prerequisite(s): (STAT 3654 or CMDA 3654 or CS 3654) and (CMDA 2006 or STAT 3104 or STAT 4106 or STAT 4706)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4654, CS 4654

STAT 4664 - Computational Intensive Stochastic Modleing (3 credits)
Stochastic modeling methods with an emphasis in computing are taught. Select concepts from the classical and Bayesian paradigms are explored to provide multiple perspectives for how to learn from complex, datasets. There is particular focus on nested, spatial, and time series models.
Prerequisite(s): (STAT 4106 or CMDA 3605) and (CS 1114 or CS 1064 or STAT 2005)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CMDA 4664

STAT 4705 - Probability and Statistics for Engineers (3 credits)
Basic concepts of probability and statistics with emphasis on engineering applications. 4705: Probability, random variables, sampling distributions, estimation, hypothesis testing, simple linear regression correlation, one-way analysis of variance. 4706: Multiple regression, analysis of variance, factorial and fractional experiments. Only one of the courses 3704, 4604, 4705, 4714, and 4724 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4706 - Probability and Statistics for Engineers (3 credits)
Basic concepts of probability and statistics with emphasis on engineering applications. 4705: Probability, random variables, sampling distributions, estimation, hypothesis testing, simple linear regression correlation, one-way analysis of variance. 4706: Multiple regression, analysis of variance, factorial and fractional experiments. Only one of the courses 3704, 4604, 4705, and 4714 may be taken for credit.
Prerequisite(s): STAT 4705 or STAT 4105 or ISE 2024
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4714 - Probability and Statistics for Electrical Engineers (3 credits)
Introduction to the concepts of probability, random variables, estimation, hypothesis testing, regression, and analysis of variance with emphasis on application in electrical engineering. Only one of the courses 3704, 4604, 4705, 4714 and 4724 may be taken for credit.
Prerequisite(s): MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4744 - Deep Learning (3 credits)
Introduction to deep learning, including algorithms, theoretical motivations, and implementation in practice. Basic neural network architectures and optimizations. Multilayer perceptrons, backpropagation, automatic differentiation, and stochastic gradient descent. Convolutional neural networks, recurrent neural networks and the attention mechanism. Generative models, variational autoencoders, and generative adversarial networks. Reinforcement learning, Q learning and design of simple AI systems. Python programming language. Emphasis on efficient implementation, optimization, and scalability. Creation of deep learning models in the context of different types of real applications such as image classification and language processing.
Prerequisite(s): (STAT 3104 or CMDA 2006) and (STAT 4214 or CMDA 4654 or STAT 4654 or CS 4654)
Instructional Contact Hours: (3 Lec, 3 Crd)

STAT 4804 - Elementary Econometrics (3 credits)
Economic applications of mathematical and statistical techniques: regression, estimators, hypothesis testing, lagged variables, discrete variables, violations of assumptions, simultaneous equations.
Prerequisite(s): AAEC 1005 and (STAT 3615 or STAT 3005 or STAT 3604 or BIT 2405)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: AAEC 4804

STAT 4964 - Field Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4974H - Independent Study (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

STAT 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

STAT 4994H - Undergraduate Research (1-19 credits)
Honors section.
Instructional Contact Hours: Variable credit course

Statistics Majors with Statistical Data Science Option

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
STAT 3006	Statistical Methods	3
STAT 3104	Probability and Distributions	3
STAT 4105	Theoretical Statistics	3
STAT 4106	Theoretical Statistics	3

STAT 4204	Experimental Designs	3
STAT 4214	Methods of Regression Analysis	3
STAT 4444	Applied Bayesian Statistics	3
Subtotal		21
Major Requirements		
STAT/CMDA/CS 3654	Introductory Data Analytics and Visualization	3
STAT 4004	Methods of Statistical Computing	3
STAT 4024	Communication in Statistical Collaborations	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2114	Introduction to Linear Algebra	3
*All students completing a B.S. in Statistics must complete STAT 3005 Statistical Methods and MATH 1225-1226. This requirement is included in Pathways Concept 5.		
Select one of the following:		3
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Subtotal		18
Option Required Courses		
STAT/CMDA/CS 4654	Intermediate Data Analytics and Machine Learning	3
Select two of the following:		6
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
CS 2064	Intermediate Programming in Python	
CS 2114	Software Design and Data Structures	
STAT 3094	SAS Programming	
**These courses must be different from the courses completed to meet the computer programming requirements in the Major Requirements.		
Restricted Electives		
Select four of the following (at least **two** must be STAT)		12
STAT 3204	Data Visualization	
STAT/CMDA 3274	Introduction to Sports Analytics Research	
STAT 3504	Nonparametric Statistics	
STAT/CMDA 4274	Sports Analytics Statistical Research	
STAT 4364	Introduction to Statistical Genomics	
STAT 4504	Applied Multivariate Analysis	
STAT 4514	Introduction to Categorical Data Analysis	
STAT 4524	Sample Survey Methods	
STAT 4534	Applied Statistical Time Series Analysis	
STAT 4584	Advanced Calculus for Statistics	
or MATH 3224	Advanced Calculus	
STAT/CMDA 4664	Computational Intensive Stochastic Modleing	
STAT 4744	Deep Learning	
STAT/AAEC 4804	Elementary Econometrics [1]	
STAT 4964/ AAEC 4804	Field Study [2]	
BIT 3424/ AAEC 4804	Introduction to Business Analytics Modeling [3]	
BIT 3434/ AAEC 4804	Advanced Modeling for Business Analytics [3]	
BIT 4544	Artificial Intelligence, Machine Learning, and Deep Learning in BIT [3,4]	
CS 4234	Parallel Computation [3]	
ECE 4424/ CS 4824	Machine Learning [3]	
MATH 4454	Applied Mathematical Modeling [3]	
ISE 4404	Statistical Quality Control [3]	
GEOG 4314/ GEOS 4354	Spatial Analysis in Geographic Information Systems [3]	
GEOG/GEOS 4354	Introduction to Remote Sensing [3]	
Subtotal		21
Free Electives		
Select remaining credits required for the degree:		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
To fulfill the Pathways Concept 4: Reasoning in the Natural Sciences requirements, only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected.		
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (required of all students majoring in Statistics; 5F)	8
STAT 3005	Statistical Methods (required of all students majoring in Statistics; 5F)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 in design + 3 in arts, or 6 in integrated design and arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 For Economic majors or minors, ECON 4304 can substitute for STAT 4804.

2 A maximum of 3 credits from either STAT 4964 (for an internship or other summer experience) or STAT 4994 may count as a Statistics elective with prior approval from the department

[3] An upper-level course that is not offered by the Department of Statistics. Be aware of all prerequisites.
[4] Be aware that priority enrollment is given to BIT majors.

Satisfactory Progress Towards Degree and Minimum Grade Requirements

- Within the first two attempts, including attempts ending in course withdrawal, students must earn a C- or better in all MATH, STAT, or CS designated courses for the degree (or equivalents thereof).
- It is recommended that, upon attempting 72 credit hours, students will have completed STAT 3005 Statistical Methods, MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2114 Introduction to Linear Algebra, MATH 2204 Introduction to Multivariable Calculus, and CS 1064 Introduction to Programming in Python or CS 1114 Introduction to Software Design.
- Upon having attempted 90 semester credits, students must have an in-major GPA of 2.00 or better.

Graduation Requirements

Virginia Tech requires 120 credit hours to graduate with a GPA of 2.0 or greater for all hours attempted. The 120 credit hours must include all required courses for the statistics major as outlined in this check-sheet. Within the first two attempts, including attempts ending in course withdrawal, students must earn a C- or better in all MATH, STAT, or CS designated courses for the degree (or equivalents thereof). In addition, students must have an in-major GPA of 2.0 or greater. All STAT courses, any course taken to fulfill Statistical Data Science option elective credit, and all required MATH and CS courses will be used to calculate in-major GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional STAT courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses listed on this checksheet may have prerequisites; please consult the Undergraduate Course Catalog or check with your advisor for more information.

Acceptable Substitutions

Note: CMDA 2005-CMDA 2006 is equivalent to all the following: STAT 3005 **AND** STAT 3006 **AND** STAT 3104 **AND** (MATH 2214 OR MATH 2214H) **AND** (MATH 2204 OR MATH 2204H)

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.Course Substitutions

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Statistics Majors with Statistical Methods and Theory Option

Code	Title	Credits
Degree Core Requirements		
STAT 3006	Statistical Methods	3
STAT 3104	Probability and Distributions	3
STAT 4105	Theoretical Statistics	3
STAT 4106	Theoretical Statistics	3
STAT 4204	Experimental Designs	3
STAT 4214	Methods of Regression Analysis	3
STAT 4444	Applied Bayesian Statistics	3
Subtotal		21
• All students completing a B.S. in Statistics must complete STAT 3005 Statistical Methods. This requirement is included in Pathways Concept 5.		
Major Requirements		
STAT/CMDA/CS 3654	Introductory Data Analytics and Visualization	3
STAT 4004	Methods of Statistical Computing	3
STAT 4024	Communication in Statistical Collaborations	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2114	Introduction to Linear Algebra	3
• All students completing a B.S. in Statistics must complete MATH 1225-1226. These courses are included in Pathways Concept 5.		
Computer Programming Required Courses. Select one of the following:		3
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Subtotal		18
Option Required Courses		
STAT 4584	Advanced Calculus for Statistics	3
or MATH 3224	Advanced Calculus	
MATH 3034	Introduction to Proofs	3
Computer Programming Required Courses. Select one of the following:		3
CS 1014	Introduction to Computational Thinking	
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
CS 2064	Intermediate Programming in Python	
CS 2114	Software Design and Data Structures	
STAT 3094	SAS Programming	
• These courses must be different from the courses completed to meet the computer programming requirements in the Major requirements.		
Restricted Electives		
Select four of the following (at least **two** must be STAT)		12
STAT 3204	Data Visualization	
STAT/CMDA 3274	Introduction to Sports Analytics Research	
STAT 3504	Nonparametric Statistics	
STAT/CMDA 4274	Sports Analytics Statistical Research	
STAT 4364	Introduction to Statistical Genomics	
STAT 4504	Applied Multivariate Analysis	
STAT 4514	Introduction to Categorical Data Analysis	
STAT 4524	Sample Survey Methods	

STAT 4534	Applied Statistical Time Series Analysis	
STAT/CMDA/ CS 4654	Intermediate Data Analytics and Machine Learning	
STAT/CMDA 4664	Computational Intensive Stochastic Modleing	
STAT 4744	Deep Learning	
STAT/AAEC 4804	Elementary Econometrics [1]	
STAT 4964	Field Study [2]	
or STAT 499	Undergraduate Research	
CS 4234	Parallel Computation [3]	
ECE 4424/ CS 4824	Machine Learning [3]	
MATH 3134	Applied Combinatorics and Graph Theory [3]	
MATH 4144	Linear Algebra II [3]	
MATH 4454	Applied Mathematical Modeling [3]	
MATH 4225	Elementary Real Analysis [3]	
ISE 4404	Statistical Quality Control [3]	
Subtotal		21
Free Electives		
Select remaining credits required for the degree:		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1A)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
To fulfill the Pathways Concept 4: Reasoning in the Natural Sciences requirements, only BIOL, CHEM, GEOS, ISC, NEUR, PHYS, and PSYC courses approved for Pathways Concept 4 may be selected.		
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (required of all students majoring in Statistics; 5F)	8
STAT 3005	Statistical Methods (required of all students majoring in Statistics; 5F)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 in design + 3 in arts, or 6 in integrated design and arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

[1] For Economic majors or minors, ECON 4304 Introduction to Econometric Methods, can substitute for STAT 4804.

[2] A maximum of 3 credits from either STAT 4964 (for an internship or other summer experience), or STAT 4994, may count as a Statistics elective with prior approval from the department.

[3] An upper-level course that is not offered by the Department of Statistics. Be aware of all prerequisites.

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
STAT 3006	Statistical Methods	3
STAT 3104	Probability and Distributions	3
STAT 4105	Theoretical Statistics	3
STAT 4106	Theoretical Statistics	3
STAT 4204	Experimental Designs	3
STAT 4214	Methods of Regression Analysis	3
STAT 4444	Applied Bayesian Statistics	3
Subtotal		21
Major Requirements		
STAT 3654	Introductory Data Analytics and Visualization	3
STAT 4004	Methods of Statistical Computing	3
STAT 4024	Communication in Statistical Collaborations	3
MATH 2204	Introduction to Multivariable Calculus	3
MATH 2114	Introduction to Linear Algebra	3
Select one of the following:		3
CS 1064	Introduction to Programming in Python	
CS 1114	Introduction to Software Design	
Subtotal		18
Option Required Courses		
STAT 4584	Advanced Calculus for Statistics	3
or MATH 3224	Advanced Calculus	
MATH 3034	Introduction to Proofs	3
Select one of the following: [4]		3
CS 1014	Introduction to Computational Thinking	
CS 1064	Introduction to Programming in Python [1]	
CS 1114	Introduction to Software Design	
CS 2064	Intermediate Programming in Python	
CS 2114	Software Design and Data Structures	
MATH 3054	[4]	
STAT 3094	SAS Programming	
Restricted Electives		
Select four of the following (at least **two** must be STAT)		12
STAT 3204	Data Visualization	
STAT 3504	Nonparametric Statistics	
STAT 4364	Introduction to Statistical Genomics	
STAT 4504	Applied Multivariate Analysis	
STAT 4514	Introduction to Categorical Data Analysis	
STAT 4524	Sample Survey Methods	
STAT 4534	Applied Statistical Time Series Analysis	
STAT 4654	Intermediate Data Analytics and Machine Learning	
STAT 4664	Computational Intensive Stochastic Modleing	

STAT 4804	Elementary Econometrics [1]	
STAT 4964	Field Study [2]	
or STAT 4994	Undergraduate Research	
CS 4234	Parallel Computation [3]	
ECE 4424	Machine Learning [3]	
MATH 3134	Applied Combinatorics and Graph Theory [3]	
MATH 4144	Linear Algebra II [3]	
MATH 4454	Applied Mathematical Modeling [3]	
MATH 4225	Elementary Real Analysis [3]	
ISE 4404	Statistical Quality Control [3]	
Subtotal		21
Free Electives		
Select remaining credits required for the degree:		13
Subtotal		13
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (1F)	3
ENGL 1106	First-Year Writing (1F)	3
ENGL 3764	Technical Writing (1F)	3
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		6
Pathways Concept 4 - Reasoning in the Natural Sciences		
Select six credits in Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04)		6
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225 & MATH 1226	Calculus of a Single Variable and Calculus of a Single Variable (required of all students majoring in Statistics; 5F)	8
STAT 3005	Statistical Methods (required of all students majoring in Statistics; 5F)	3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select 6 credits = 3 in design + 3 in arts, or 6 in integrated design and arts)		6
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Subtotal		47
Total Credits		**120**

1 For Economic majors or minors, ECON 4304 Introduction to Econometric Methods can substitute for STAT 4804 Elementary Econometrics.

2 A maximum of 3 credits from either STAT 4964 Field Study (for internships or other summer experience), or STAT 4994 Undergraduate Research may count as a Statistic elective with prior approval from the department.

3 An upper-level course that is not offered by the Department of Statistics. Be aware of *all* prerequisites.

4 These courses must be different from the course completed in the major requirements section.

Satisfactory Progress Towards Degree and Minimum Grade Requirements

- Within the first two attempts, including attempts ending in course withdrawal, students must earn a C- or better in all MATH, STAT, or CS designated courses for the degree (or equivalents thereof).
- It is recommended that, upon attempting 72 credit hours, students will have completed STAT 3005 Statistical Methods, MATH 1225 Calculus of a Single Variable, MATH 1226 Calculus of a Single Variable, MATH 2114 Introduction to Linear Algebra, MATH 2204 Introduction to Multivariable Calculus, and CS 1064 Introduction to Programming in Python or CS 1114 Introduction to Software Design.
- Upon having attempted 90 semester credits, students must have an in-major GPA of 2.00 or better.

Graduation Requirements

Virginia Tech requires 120 credit hours to graduate with a GPA of 2.0 or greater for all hours attempted. The 120 credit hours must include all required courses for the statistics major as outlined in this check-sheet. Within the first two attempts, including attempts ending in course withdrawal, students must earn a C- or better in all MATH, STAT, or CS designated courses for the degree (or equivalents thereof). In addition, students must have an in-major GPA of 2.0 or greater. All STAT courses, any course taken to fulfill Statistical Methods and Theory option elective credit, and all required MATH and CS courses will be used to calculate in-major GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional STAT courses to raise the in-major GPA to a 2.0.

Prerequisites

Some courses listed on this checksheet may have prerequisites; please consult the Undergraduate Course Catalog or check with your advisor for more information.

Acceptable Substitutions

Course Substitutions

CMDA 2005 Integrated Quantitative Sciences-CMDA 2006 Integrated Quantitative Sciences is equivalent to all the following: STAT 3005 Statistical Methods **and** STAT 3006 Statistical Methods **and** STAT 3104 Probability and Distributions **and (**MATH 2214 Introduction to Differential Equations OR MATH 2214H Introduction to Differential Equations)**and** (MATH 2204 Introduction to Multivariable Calculus **or** MATH 2204H Introduction to Multivariable Calculus)

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

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Systems Biology

Our Website (https://www.ais.science.vt.edu/academics/sysbio.html)

Overview

The Systems Biology program is a joint effort of the departments of Biological Sciences, Physics, Chemistry, Mathematics and Computer Science. The program resides in, and is organized as a division of, the College of Science's Academy of Integrated Science.

A "systems approach" to biology involves the study of the biological, chemical, and physical processes within living organisms as they interact in complex ways to produce life-supporting behaviors. The Virginia Tech program in Systems Biology focuses on the powerful, emerging paradigm of molecular systems biology, i.e., on computational, systems-level approaches that connect the biochemical and genetic properties of individual macromolecules (DNA, RNA, protein, lipids, polysaccharides) with the physiological behavior of living cells and tissues. These levels of biological organization, which comprise the gap between interacting macromolecules and cell physiology, embody an active area of research producing technological and biomedical innovations. The Systems Biology program bridges the molecular/cell divide, training students for employment or graduate education in this burgeoning field.

Satisfactory Progress

University policy requires that students who are making satisfactory progress toward a degree meet minimum criteria toward the General Education (Curriculum for Liberal Education or Pathways to General Education) (see "Academic Policies (p. 9)") and toward the degree.

Satisfactory progress requirements toward the B.S. in Systems Biology can be found on the major checksheet by visiting the University Registrar website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html.

Minor in Systems Biology

Please visit the University Registrar's website at https://www.registrar.vt.edu/graduation-multi-brief/checksheets.html for requirements toward a minor in Systems Biology.

- Systems Biology Major (p. 1360)

Division Leader: I. Lazar
Program Manager: C. Conley
Principle Faculty: F. Aylward, A. Banerjee, W. Baumann, A. M. Brown, Y. Cao, J. Chen, L. Childs, M. Chung, D. Cimini, S. Ciupe, S. Hauf, R. Jensen, P. Kraikivski, L. Li, and T.M. Murali

Undergraduate Course Descriptions (SYSB)

SYSB 2024 - Fundamentals of Systems Biology (3 credits)
Introduction to fundamental concepts of systems biology: biological systems, molecular regulatory networks, modeling approaches in systems biology with case studies, high-throughput data generation and bioinformatics data processing.
Prerequisite(s): MATH 1225 and (BIOL 1105 or ISC 1106H) and (CHEM 1036 or CHEM 1056 or CHEM 1056H or ISC 1106H)
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 2034 - Mathematical Methods in Systems Biology (3 credits)
Fundamental mathematical methods in systems biology, including differential equations, graph theory, Boolean mathematics, and concepts of probability. Applications of these methods to developing models of biological regulatory networks and dynamical systems. Software tools for Systems Biology.
Prerequisite(s): SYSB 2024 and MATH 1226 and (CS 1064 or CS 1114)
Corequisite(s): MATH 2114, MATH 2114H
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 3035 - Genomics and Bioinformatics (4 credits)
Bioinformatic approaches in omics, namely genomics and transcriptomics. 3035: Genomic architecture and evolution. Gene expression and post-translational regulation. Structure and function of genes and other genetic elements. Experimental techniques for generating genomic and transcriptomic data. 3036: Statistical, evolutionary, and computational models and methods to analyze omics data. Techniques for visualization and biological interpretation of omics data derived from experiments. Application of Python and R to bioinformatics. Case studies and specific applications in molecular biology, including comparative genomics, cancer, and infectious diseases.
Prerequisite(s): BIOL 2004
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3036 - Genomics and Bioinformatics (4 credits)
Bioinformatic approaches in omics, namely genomics and transcriptomics. 3035: Genomic architecture and evolution. Gene expression and post-translational regulation. Structure and function of genes and other genetic elements. Experimental techniques for generating genomic and transcriptomic data. 3036: Statistical, evolutionary, and computational models and methods to analyze omics data. Techniques for visualization and biological interpretation of omics data derived from experiments. Application of Python and R to bioinformatics. Case studies and specific applications in molecular biology, including comparative genomics, cancer, and infectious diseases.
Prerequisite(s): SYSB 3035
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3115 - Network Dynamics and Cell Physiology (4 credits)
In-depth study of how molecular regulatory networks determine the physiological properties of prokaryotic and eukaryotic cells. 3115: Biochemical reaction networks, nonlinear dynamical systems, parameter estimation, bifurcation theory, switches and oscillators, gene regulatory networks, signaling pathways, metabolic networks, neural networks, applications. 3116: Stochastic effects, cell cycle and cancer, spatial effects, motility, development, tissue dynamics, applications.
Prerequisite(s): SYSB 2034
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 3116 - Network Dynamics and Cell Physiology (4 credits)
In-depth study of how molecular regulatory networks determine the physiological properties of prokaryotic and eukaryotic cells. 3115: Biochemical reaction networks, nonlinear dynamical systems, parameter estimation, bifurcation theory, switches and oscillators, gene regulatory networks, signaling pathways, metabolic networks, neural networks, applications. 3116: Stochastic effects, cell cycle and cancer, spatial effects, motility, development, tissue dynamics, applications.
Prerequisite(s): SYSB 3115
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

SYSB 4024 - Careers and Professionalism in Systems Biology (2 credits)
Career planning, interviewing skills, and training in written and oral communication in systems biology. Critical evaluation of research, effective communication of scientific results, ethical standards in science, societal trends.
Prerequisite(s): SYSB 3036 and SYSB 3116
Corequisite(s): SYSB 4065
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4065 - Research Experience in Systems Biology (2 credits)
Training and practical experience in the conduct of systems biology research. 4065: Plan a research project, develop a research hypothesis, and perform preliminary testing and analysis. 4066: Execute, refine, complete, and document the projects results.
Prerequisite(s): SYSB 3036 and SYSB 3116
Corequisite(s): SYSB 4135
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4066 - Research Experience in Systems Biology (2 credits)
Training and practical experience in the conduct of systems biology research. 4065: Plan a research project, develop a research hypothesis, and perform preliminary testing and analysis. 4066: Execute, refine, complete, and document the projects results.
Prerequisite(s): SYSB 4065
Corequisite(s): SYSB 4136
Instructional Contact Hours: (2 Lec, 2 Crd)

SYSB 4114 - Applied Models of Gene Regulatory Networks (3 credits)
Dynamic modeling of gene regulatory networks. Gene regulatory networks with oscillatory and switch-like dynamic behavior. Design of synthetic genetic switches and oscillators. Modeling gene regulation controlling cell fate, cell differentiation, cell-to-cell communication, synchronization and developmental processes. Real-world research problems and applications.
Prerequisite(s): SYSB 2034 and SYSB 3116
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 4224 - Big Data Analysis Methods in Systems Biology (3 credits)
Big data analysis in systems biology. Emphasis on data storage/retrieval and curation, statistical modeling of gene expression, enrichment analysis, clustering, parameter optimization and estimation in systems biology models, linear and nonlinear classification methods.
Prerequisite(s): (SYSB 2034 or MATH 1226) and (STAT 3005 or STAT 3615)
Instructional Contact Hours: (3 Lec, 3 Crd)

SYSB 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

SYSB 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Systems Biology Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
SYSB 2024	Fundamentals of Systems Biology [1,2]	3
SYSB 3035	Genomics and Bioinformatics [1,2]	4
SYSB 3115	Network Dynamics and Cell Physiology [1,2]	4
SYSB 4065	Research Experience in Systems Biology [1,2]	2
SYSB 4024	Careers and Professionalism in Systems Biology [1,2]	2
SYSB 2034	Mathematical Methods in Systems Biology [1,2]	3
SYSB 3036	Genomics and Bioinformatics [1,2]	4
SYSB 3116	Network Dynamics and Cell Physiology [1,2]	4
SYSB 4066	Research Experience in Systems Biology [1,2]	2
SYSB 4114	Applied Models of Gene Regulatory Networks [1]	3
Subtotal		31
Additional Mathematics and Science		
BIOL 1105	Principles of Biology [1, 2]	3
BIOL 1106	Principles of Biology [1, 2]	3
BIOL 1115	Principles of Biology Laboratory [1,2]	1
BIOL 1116	Principles of Biology Laboratory [1,2]	1
BIOL 2004	Genetics [1,2]	3
MATH 2114	Introduction to Linear Algebra [1,2]	3
CHEM 1035	General Chemistry [1,2]	3
CHEM 1036	General Chemistry [1,2]	3
CHEM 1045	General Chemistry Laboratory [1,2]	1
CHEM 1046	General Chemistry Laboratory [1,2]	1
CHEM 2535	Organic Chemistry [1,2]	3
CHEM 2545	Organic Chemistry Laboratory [1,2]	1
CS 1064	Introduction to Programming in Python [2]	3
Subtotal		29
Restricted Electives		**11**
Select four or more of the following: [3]		
BCHM 2024	Concepts of Biochemistry [1,2]	
BCHM 2354	Biochemical Techniques [1,2]	
BCHM 3114	Biochemistry for Biotechnology and the Life Sciences [1,2]	
BCHM 4054	Genomics [1,2]	
BCHM 4115	General Biochemistry [1,2]	
BCHM 4116	General Biochemistry [1,2]	
BIOL 2134	Cell Function and Differentiation [1,2]	
BIOL 3134	Human Genetics [1,2]	
BIOL 3774	Molecular Biology [1,2]	
BIOL 4624	Microbial Genetics [1,2]	
BIOL 4634	Microbial Physiology [1,2]	
BIOL 4704	Immunology [1,2]	
BIOL 4734	Inflammation Biology [1,2]	
BIOL 4854	Cytogenetics [1,2]	
BIOL 4874	Cancer Biology [1,2]	
BIOL 4844	Proteomics and Biological Mass Spectrometry [1,2]	
BIOL 4884	Cell Biology [1,2]	
CHEM 2536	Organic Chemistry [1,2]	
CHEM 2546	Organic Chemistry Laboratory [1,2]	
CHEM 3615	Physical Chemistry [1,2]	
CHEM 4584	Bioorganic Chemistry [1,2]	
CHEM 4615	Physical Chemistry for the Life Sciences [1,2]	
CHEM 4616	Physical Chemistry for the Life Sciences [1,2]	
CMDA 3605	Mathematical Modeling: Methods and Tools [1,2]	
CMDA 3606	Mathematical Modeling: Methods and Tools [1,2]	
CMDA/CS/ STAT 3654	Introductory Data Analytics and Visualization [1,2]	
CMDA/CS/ STAT 4654	Intermediate Data Analytics and Machine Learning [1,2]	

CS 2064	Intermediate Programming in Python [1, 2]	
CS 2114	Software Design and Data Structures [1,2]	
CS/MATH 3414	Numerical Methods [1,2]	
CS 3824	Introduction to Computational Biology and Bioinformatics [1,2]	
CS/CMDA 3634	Computer Science Foundations for Computational Modeling & Data Analytics [1,2]	
CS 4214	Simulation and Modeling [1,2]	
CS 4824	Machine Learning [1,2]	
CS 4884	Computational Biology and Bioinformatics Capstone [1,2]	
MATH 2204	Introduction to Multivariable Calculus [1,2]	
MATH 2214	Introduction to Differential Equations [1,2]	
MATH 2534	Introduction to Discrete Mathematics [1]	
MATH 3134	Applied Combinatorics and Graph Theory [1,2]	
MATH 4254	Chaos and Dynamical Systems [1,2]	
MATH 4445	Introduction to Numerical Analysis [1,2]	
MATH 4446	Introduction to Numerical Analysis [1,2]	
MATH 4454	Applied Mathematical Modeling [1,2]	
NEUR 2025	Introduction to Neuroscience [1]	
NEUR 2026	Introduction to Neuroscience [1,2]	
NEUR 3044	Cellular and Molecular Neuroscience [1,2]	
NEUR 3084	Cognitive Neuroscience [1,2]	
STAT 3006	Statistical Methods [1,2]	
STAT 3616	Biological Statistics [1,2]	
STAT 4094	Introduction to Programming in R [1,2]	
STAT 3104	Probability and Distributions [1,2]	
STAT 4364	Introduction to Statistical Genomics [1,2]	
STAT/CMDA 4664	Computational Intensive Stochastic Modleing [1,2]	
SYSB 4224	Big Data Analysis Methods in Systems Biology [1]	
Subtotal		**11**
Pathways to General Education		**49**
Pathways Concept 1 - Discourse		
Select six credits in Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F)		
Select three credits in Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		
Pathways Concept 2 - Critical Thinking in the Humanities		
Select six credits in Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		
Pathways Concept 3 - Reasoning in the Social Sciences		
Select six credits in Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03)		
Pathways Concept 4 - Reasoning in the Natural Sciences		
PHYS 2205	General Physics	
PHYS 2215	General Physics Laboratory	
PHYS 2206	General Physics	
PHYS 2216	General Physics Laboratory	
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1225	Calculus of a Single Variable	
MATH 1226	Calculus of a Single Variable	
STAT 3005	Statistical Methods	
STAT 3615	Biological Statistics	
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Select three credits in Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		
Select three credits in Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Select three credits in Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		
Subtotal		49
Total Credits		**120**

1 Courses have prerequisites or corequisites. Students are required to double check course prerequisites and equivalents. Please see your advisor or consult the Undergraduate Course Catalog for more information.

2 **In Major GPA**: Courses used to calculate in-major GPA.

3 At least 6 hours must be at the 3000 or 4000 level; at least 3 credit hours must be at least 4000 level.

Upon having completed 72 credit hours (including transfer, AP, advanced standing, credit by examination, course withdrawal) students must have completed the following courses with a grade of C- or better in two or fewer attempts (including attempts that were withdrawn):

BIOL 1105 Principles of Biology, **AND** BIOL 1106 Principles of Biology **AND** BIOL 1115 Principles of Biology Laboratory **AND** BIOL 1116 Principles of Biology Laboratory **AND** BIOL 2004 Genetics **AND** CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry **AND** CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory **AND** CHEM 2535 Organic Chemistry **AND** MATH 1225 Calculus of a Single Variable **AND** MATH 1226 Calculus of a Single Variable, PHYS 2205 General Physics **AND** PHYS 2206 General Physics **AND** PHYS 2215 General Physics Laboratory **AND**PHYS 2216 General Physics Laboratory. This also applies to acceptable substitutions.

Graduation Requirements

120 credit hours are required for graduation. These credits must include the courses required for the major (see above section). To graduate, a student must have at least a 2.0 in-major GPA and 2.0 overall GPA. If 120 credit hours are reached and a student does not meet the GPA requirement, the student must take additional in-major courses to raise the in-major GPA to a 2.0.

Acceptable Substitutions

- BIOL 1105 Principles of Biology **AND** BIOL 1115 Principles of Biology Laboratory **AND** BIOL 1116 Principles of Biology Laboratory **AND** CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry **AND** CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory **AND** PHYS 2205 General Physics **AND** PHYS 2206 General Physics **AND** PHYS 2215 General Physics Laboratory **AND PHYS 2216 General Physics Laboratory** can be substituted with ISC 1105 Integrated Science I **AND** ISC 1106 Integrated Science I **AND** ISC 1115 Integrated Science Laboratory

I **AND** ISC 1116 Integrated Science Laboratory I **AND** ISC 2105 Integrated Science II **AND** ISC 2106 Integrated Science II **AND** ISC 2115 Integrated Science Laboratory II **AND** ISC 2116 Integrated Science Laboratory II

- CHEM 1035 General Chemistry **AND** CHEM 1036 General Chemistry can be substituted with CHEM 1055 General Chemistry for Chemistry Majors **AND** CHEM 1056 General Chemistry for Chemistry Majors
- CHEM 1045 General Chemistry Laboratory **AND** CHEM 1046 General Chemistry Laboratory c an be substituted with CHEM 1065 General Chemistry for Chemistry Majors Lab **AND** CHEM 1066 General Chemistry for Chemistry Majors Lab
- CHEM 2535 Organic Chemistry can be substituted with CHEM 2565 Principles of Organic Chemistry
- CHEM 2545 Organic Chemistry Laboratory can be substituted with CHEM 2555 Organic Synthesis and Techniques Lab
- CHEM 4615 Physical Chemistry for the Life Sciences **AND** CHEM 4616 Physical Chemistry for the Life Sciences can be substituted with CHEM 3615 Physical Chemistry **AND** CHEM 3616 Physical Chemistry
- CS 1064 Introduction to Programming in Python can be substituted with CS 1114 Introduction to Software Design
- MATH 2114 Introduction to Linear Algebra can be substituted with MATH 2114H Introduction to Linear Algebra
- PHYS 2205 General Physics **AND** PHYS 2206 General Physics **AND** PHYS 2215 General Physics Laboratory **AND** PHYS 2216 General Physics Laboratory can be substituted with PHYS 2305 Foundations of Physics **AND** PHYS 2306 Foundations of Physics

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation. Please consult the Undergraduate Catalog for details.

Honors College

Our Website (http://www.honorscollege.vt.edu)

Our Mission

The Honors College seeks to inspire and facilitate an extraordinary undergraduate education for a diverse student body of exceptional motivation. Utilizing a flexible curricular framework with a strategic array of experiences, opportunities, and facilities, the College pioneers progressive, innovative approaches to undergraduate education that can be scaled up across the university.

Admissions

First-year and transfer applicants indicate their interest in the Honors College on their Coalition application, which prompts further review by the Honors College. Rather than establishing a numerical minimum for GPA and test scores, the Honors College looks holistically at a first-year applicant's overall academic record and experiences. We value quality of engagement (rather than sheer quantity), self-awareness, reflection on involvement, and authenticity.

Transfer students are similarly considered, but they must have a cumulative GPA of 3.40 or better at their previous institution to be eligible for review.

Currently enrolled Virginia Tech students may apply to the Honors College at the end of each fall or spring semester provided they have achieved a 3.40 or better cumulative GPA and have at least four (4) semesters remaining at Virginia Tech before they graduate.

Honors Academic Requirements

Virginia Tech Honors College students must complete all Honors Academic Requirements to earn an Honors Laureate Diploma or complete the Honors Minor. Honors Academic Requirements were updated for students entering the Honors College in Fall 2023 or later. Cohort-specific requirements are below:

For students who entered the Honors College in Fall 2023 or later

Every Honors Laureate Program student or every student pursuing the Honors Minor in Collaborative Discovery must meet four Honors Academic Requirements in total, two of which must be met by the end of two traditional, consecutive semesters in Honors:

1. Complete the Honors Gateway
   a. Entering the Honors College requires completing all modules and assignments in this Canvas course, which serves as both the required virtual orientation course and the Honors College application (for current Virginia Tech students, only).
2. Complete UH 1404 Principles of Collaborative Discovery
   a. All Honors students must complete UH 1404 with a passing grade by the end of their first two semesters in Honors. Students who fail to meet this requirement will be removed from the Honors College.
   b. We strongly recommend that students register for UH 1404 for their first semester in Honors to ensure their spot in the course is secured well before this requirement is due.
3. Meet the GPA Requirement
   a. All Honors students must achieve a 3.4 cumulative GPA by the end of their first two semesters in Honors. After this deadline, Honors does not check GPA again until graduation. Students who fail to meet this requirement will be removed from the Honors College.
4. Satisfy Honors completion requirements
   a. Students should make consistent progress toward the completion of at least 24 honors credits and achieve a final cumulative GPA of 3.4 or better.
   b. The Honors Laureate Diploma (HLD) appears on the Virginia Tech diploma as a special designation and is not a separate document. Visit the Honors Laureate Diploma page (https://honorscollege.vt.edu/Academics/HLD/HLD-2023.html) for more information about the structural credit requirements of the HLD. The Honors Minor in Collaborative Discovery appears on a student's transcript.

For students who entered the Honors College in Spring 2023 or earlier

Every Honors Laureate Program student or every student pursuing the Honors Minor in Transdisciplinary Praxis must meet four Honors Academic Requirements in total, two of which must be met by the end of two traditional, consecutive semesters in Honors:

1. Receive approval on their plan to earn the Honors Laureate Diploma (HLD Plan)

   a. Plan approval happens in the Honors Peer Advising Center. Schedule an appointment here: HPAC (https://honorscollege.vt.edu/Academics/hpac.html).
2. Achieve a 3.6 or better cumulative GPA
   a. A 3.60 or better cumulative GPA from the semester at Virginia Tech immediately previous to entering the Honors College may count toward this requirement.
   b. Students who do not meet requirements #1 and #2 by the end of two traditional, consecutive semesters in Honors will be removed from the Honors College.
3. After meeting #1 and #2, students enter the GPA Flex Period, a time when Honors does not monitor GPA again until graduation. Students should make consistent progress toward 30 total honors credits.
   a. Courses taken for Honors credit must be graded on the A–F scale unless P/F is the only option.
   b. Students who entered the Honors College in Spring 2021 or earlier who never receive Honors Laureate Diploma plan approval and, therefore, never enter the GPA Flex Period are required to continue to maintain a 3.60 or better cumulative GPA after every semester until the planner is approved or upon graduation.
4. To graduate in Honors, students must achieve a 3.3 or better cumulative GPA and complete honors credit requirements.
   a. The Honors Laureate Diploma (HLD) appears on the Virginia Tech diploma as a special designation and is not a separate document. Visit the Honors Laureate Diploma page (https://honorscollege.vt.edu/Academics/HLD/HLD-2023.html) for more information about the structural credit requirements of the HLD. The Honors Minor in Transdisciplinary Praxis appears on a student's transcript.

Honors Minor

The Honors College offers its own, optional academic minor. Students who enter the Honors College in Fall 2023 or later have access to the Honors Minor in Collaborative Discovery. All students in earlier cohorts have access to the original version of the minor: the Honors Minor in Transdisciplinary Praxis.

Pursuing the Honors Minor in Collaborative Discovery will both help you stand out from the crowd and prepare you for "what's next." By completing the Honors Minor, you will:

- Automatically also complete the Honors Laureate Diploma
- Add considerable value beyond your disciplinary education
- Gain a deeper understanding of the productive value of disciplinary differences and harness those differences through transdisciplinary collaboration
- Become an extremely valuable and desirable colleague wherever you may go after graduating

Honors Academic Requirements apply to students whether they pursue the Honors Laureate Diploma or the Honors Minor. For more information about the Minor, visit the Honors Minor page (https://honorscollege.vt.edu/Academics/HonorsCollegeMinor.html) of our website.

Honors Collaborative Discovery Diploma

The Honors Collaborative Discovery Diploma (HCDD) is limited to students in 14 participating programs that span engineering, science, business, design arts, humanities, and policy. Only students in the 2023, 2024, 2025, 2026 graduating classes may receive the HCDD in this four-year pilot program. The Calhoun Honors Discovery Program is at capacity with 140 students. Visit the website for more information: **https://honorscollege.vt.edu/chdp.html**.

The Calhoun Honors Discovery Program (CHDP) combines a structured disciplinary education with an open-ended, collaborative, and transdisciplinary discovery process. Students collaborate with one another across disciplines, as well as work alongside our faculty, industry, and non-profit partners. After four years of learning the process of discovery, innovation, and problem-solving, students will be prepared to face the real world. Under this new learning platform, students will graduate from Virginia Tech with the skills and knowledge needed to lead collaborative sociotechnical innovation and live out our motto Ut Prosim, "That I May Serve."

Honors Advising

The Honors Peer Advising Center enables honors students to meet individually with trained Honors Peer Advisors to talk through processes and resources to answer Honors-related questions. The honors staff also welcomes student appointments and walk-in visits. Each staff member has a distinct specialization with which they can assist students. Furthermore, advising for major national and international scholarships is available through the Honors College for all Virginia Tech students.

Honors Living-Learning Programs

Honors College students have two Honors community options: the Hillcrest Honors living–learning community houses about 100 students in Hillcrest Hall and the Honors Residential Commons houses about 320 students in East Ambler Johnston Hall. Both communities are multigenerational and multidisciplinary, housing first-year students to fifth-year seniors from all seven colleges at Virginia Tech.

Honors students are not required to live in an Honors living–learning program. Many students live off-campus or in other living-learning programs.

Dean: Paul Knox
Associate Dean for Academic Affairs: Paul Heilker[2,4,7]
Associate Dean for Finance and Administration: Lefter Daku
Assistant Dean: Sara Vandyke
Director of Programs and Partnerships: Michelle Kovac
Director of Professional Development, National and International Scholarships: Christina McIntyre
Director of Admissions and Scholarships: Russell Shrader
Technical Director, Calhoun Honors Discovery Program: Neal Henshaw
Honors Laureate Program Coordinator: Mary Helm
Business Office Coordinator: Eni Gosselin
Administrative Assistant: Ashlee Cox
Communications Specialist: Erin Deitzel
Collegiate Associate Professor, College of Liberal Arts and Human Sciences: Anne-Lise Velez
Collegiate Assistant Professor: Rachael Budowle, Michael Kretser
Collegiate Associate Professor: Stephanie Lewis
Professor of Practice: Enric Ruiz-Geli

Undergraduate Course Descriptions (UH)

UH 1404 - Principles of Collaborative Discovery (3 credits)
Introduction to honors education at Virginia Tech. Disciplinarity, interdisciplinarity, multidisciplinarity, and transdisciplinarity. Qualitative and quantitative research methods. "Wicked problems," systems thinking, and collaborative discovery. Problem analysis and iterative thinking. Ethical dimensions of trans-sector activity.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 1504 - PGS PStudy Abroad Pre-Departure Seminar (2 credits)
Orientation for Presidential Global Scholars (PGS) participants. Introduction to theories of culture and cross-cultural competence. Survey of Swiss culture, history, and politics. Introduction to PGS faculty and research interests. Development of individual research questions; transdisciplinary research on critical issues in U.S. contexts. Critical travel and safety information.
Instructional Contact Hours: (2 Lec, 2 Crd)

UH 1604 - Introduction to Honors Quantitative and Qualitative Research Practices (3 credits)
Introduction to critical practices in undergraduate quantitative and qualitative research for Honors College students, including generating focused research questions, finding scholarly literature, organizing data, conducting ethical research, collaborative research practices, and identifying venues to present research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 2124 - Honors Reading Seminar (1 credit)
Reading based sections in which small groups of students practice discussion, debate, and argumentation grounded in a topic or genre of reading of their groups choosing. Honors standing. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2504 - Topics in Discourse and Global Citizenship (3 credits)
Discovery, analysis, creation, and evaluation of written, spoken, and visual presentation of ideas in cross-cultural contexts. Special attention to the relationship of rhetoric to effective participation in academic, professional, and public/civic problem-solving. Course cannot be repeated for credit.
Corequisite(s): UH 2524, UH 2534, UH 2544, UH 2554, UH 4994
Pathway Concept Area(s): 1A Discourse Advanced, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2514 - Topics in Quantitative/Computational Thinking and Global Citizenship (3 credits)
Application of quantitative/computational thinking in cross-cultural civic/public contexts. Use of quantitative/computational thinking to frame a question and devise a solution related to a civic/public issue. Drawing valid quantitative inferences about civic/public and cross-cultural issues characterized by inherent uncertainty. Evaluating conclusions or decisions about civic/public issues based on quantitative data. Ethical considerations of quantitative/computational thinking in cross-cultural civic/public issues. Course cannot be repeated for credit.
Corequisite(s): UH 4994
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2524 - Topics in Natural Sciences and Global Citizenship (3 credits)
Study of a specific branch of the natural sciences, especially as it intersects with public/civic controversies and problem-solving. Cross-cultural perspectives on the nature, purposes, and processes of scientific inquiry and knowledge. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2534, UH 2544, UH 2554, UH 4994
Pathway Concept Area(s): 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2544 - Topics in Social Science and Global Citizenship (3 credits)
Study of the behavior and actions of individuals, groups, and institutions within larger social, economic, political, and geographic contexts, especially in cross-cultural settings. Special attention to social beliefs and actions as they influence public/civic controversies and problem-solving. Examination of the influence of value and beliefs on human behavior and social relationships. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2524, UH 2534, UH 2554, UH 4994
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2554 - Topics in Humanities and Global Citizenship (3 credits)
Analysis and interpretation of texts and other artifacts to understand ideas, values, and identities in cross-cultural contexts. Special attention to the functions of narrative and rhetoric in public/civic controversies and problem- solving. Situating local/regional texts and artifacts in global frameworks. Course cannot be repeated for credit.
Corequisite(s): UH 2504, UH 2524, UH 2534, UH 2544, UH 4994
Pathway Concept Area(s): 2 Critical Thinking Humanities, 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2604 - Intermediate Honors Quantitative and Qualitative Research Practices (3 credits)
Intermediate study of critical practices in quantitative and qualitative research for Honors College students, including identifying funding opportunities for research, collaborating across disciplines, designing introductory research protocols, managing research projects, and using posters to present research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 2744 - Foundational Topics in Computing in Technology Innovation for Societal Impa (1 credit)
Foundational study of applications of computational thinking in technology innovation for societal impact. Key components of computing and their interrelation. Uses of computational thinking to frame questions and devise solutions. Implementation of simple computational processes and tools. Construction of computational models to analyze and draw inferences about complex and uncertain phenomena. Evaluation of knowledge based on quantitative data. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 5F Quant & Comp Thnk Found., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2754 - Advanced Topics in Computing in Technology Innovation for Societal Impact (1 credit)
Advanced study of applications of computational thinking in technology innovation for societal impact. Uses of computational thinking to frame questions and devise solutions. Application of computational processes and tools. Application and evaluation of computational models to analyze and draw inferences about dynamic and uncertain phenomena. Impacts of computing and information technology on society. Ethical dimensions of computing for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): MATH 1225 or MATH 1524 or MATH 1535
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2764 - Advanced Topics in Engineering in Technology Innovation for Societal Impact (1 credit)
Study of applications of computer and systems engineering in technology innovation for societal impact. Application of computer and systems engineering processes and tools to analyze complex or large-scale phenomena. Application and evaluation of computer and systems engineering approaches to analyze and draw inferences about the feasibility and effectiveness of technological innovations. Impacts of computer and systems engineering on society and the environment. Ethical dimensions of computer and systems engineering for technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Prerequisite(s): UH 2744
Pathway Concept Area(s): 5A Quant & Comp Thnk Adv., 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2814 - Topics in Social Sciences for Technology Innovation for Societal Impact (1 credit)
Threshold concepts in social sciences related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas about the behavior of individuals, groups, and institutions related to technology innovation within larger social, economic, political, and geographic contexts. Use of key concepts in the social sciences to examine the ethical dimensions of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2824 - Topics in the Arts for Technology Innovation for Societal Impact (1 credit)
Application of threshold concepts in the fine arts to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas for non-specialists about the formal elements, process, meaning, and value of the fine arts in technology innovation. Use of key concepts in the fine arts to examine the ethical dimensions of technological and societal innovation. May be repeated 2 times with different content for a maximum of 3 credits.
Pathway Concept Area(s): 6A Critique & Practice in Arts, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 3 credit hours

UH 2834 - Topics in Humanities for Technology Innovation for Societal Impact (1 credit)
Threshold concepts in the humanities related to collaborative, transdisciplinary technology innovation for societal impact. Study of key ideas and values related to technology innovation in various spatial, cultural, and temporal contexts. Use of key concepts in the humanities such as historical/cultural context and the nature of the good to examine the ethics of technological and societal innovation. May be repeated 5 times with different content for a maximum of 6 credits.
Pathway Concept Area(s): 2 Critical Thinking Humanities, 10 Ethical Reasoning
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

UH 2855 - Calhoun Transdisciplinary Fusion Studio (3 credits)
Introduction to transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 2855: Collaborative problem-setting. Evaluative criteria for technology innovation: feasibility (can it be made?), viability (is it financially sensible?), desirability (do people want it?), and sustainability (can it work long-term?). Introduction to design thinking. Ethical dimensions of collaborative technology innovation for societal impact. 2856: Collaborative problem-solving. Introduction to quantitative and qualitative research methods. Optimization and integration. Design thinking and component prototyping. Ethical dimensions of collaborative technology innovation for societal impact. Design Lab/Studio.
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 2856 - Calhoun Transdisciplinary Fusion Studio (3 credits)
Introduction to transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 2855: Collaborative problem-setting. Evaluative criteria for technology innovation: feasibility (can it be made?), viability (is it financially sensible?), desirability (do people want it?), and sustainability (can it work long-term?). Introduction to design thinking. Ethical dimensions of collaborative technology innovation for societal impact. 2856: Collaborative problem-solving. Introduction to quantitative and qualitative research methods. Optimization and integration. Design thinking and component prototyping. Ethical dimensions of collaborative technology innovation for societal impact. Design Lab/Studio.
Prerequisite(s): UH 2855
Pathway Concept Area(s): 6D Critique & Prac in Design, 10 Ethical Reasoning
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 3204 - Honors Service Learning (3 credits)
A two-part course. Part one: three hours a week working directly with community partners. Part two: a one-hour class to reflect on the service experience and discuss readings and other course materials that place the experiential learning into a theoretical context. Open to all Honors students. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

UH 3504 - Topics in Honors Transdisciplinary Seminars (3 credits)
Exploration of transdisciplinary issues and questions. Analysis of complex topics from multiple points of view. Collaborative discussion and critique. Ethical decision-making across disciplines. Application of knowledge and processes from other disciplines. Variable course content. May be repeated one (1) time with different content for a maximum of 6 credit hours.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

UH 3604 - Designing Protocols for Honors Quantitative and Qualitative Research (3 credits)
Advanced study of critical practices in quantitative and qualitative research for Honors College students, including transdisciplinary project management, refining research protocols based on feasibility of data collection, maintaining research ethics and integrity, planning for data collection, and planning for dissemination of research findings.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 3614 - Data Collection and Analysis for Honors Quantitative and Qualitative Research (3 credits)
Continuing advanced study of critical practices in quantitative and qualitative research for Honors College students, including working with multiple types of data, collecting, cleaning and managing data, reporting of primary and secondary data, evaluating the work of others, and communicating conclusions to general audiences.
Instructional Contact Hours: (3 Lec, 3 Crd)

UH 3855 - Calhoun Transdisciplinary Design Studio (3 credits)
Intermediate study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 3855: Systems thinking and systems definition; identification and analysis of stakeholders; skills discovery and transdisciplinary team building; rapid prototyping. 3856: Collaborative innovation; customer discovery; evidence-based decision-making; iterative design; troubleshooting. Design Lab/Studio.
Prerequisite(s): UH 2856
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 3856 - Calhoun Transdisciplinary Design Studio (3 credits)
Intermediate study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 3855: Systems thinking and systems definition; identification and analysis of stakeholders; skills discovery and transdisciplinary team building; rapid prototyping. 3856: Collaborative innovation; customer discovery; evidence-based decision-making; iterative design; troubleshooting. Design Lab/Studio.
Prerequisite(s): UH 3855
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 3954 - Study Abroad (1-19 credits)
Honors Section.
Instructional Contact Hours: Variable credit course

UH 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4004 - Honors Tutorial (3 credits)
Small, seminar-style course of one or a few students. Students explore a specific topic that is new to them with a faculty member who provides individual attention and is an expert in that established field. Open to all Honors students. Junior Honors standing. Variable course content. Repeatable for up to six credits.
Instructional Contact Hours: (1 Lec, 6 Lab, 3 Crd)
Repeatability: up to 6 credit hours

UH 4104 - Honors Student Teach Practicum (2 credits)
For Honors students facilitating Honors courses that encourage and require student facilitation or mentorship responsibilities. Student Teaching Assistants and their sections are overseen by honors faculty or staff. Student Teaching Assistants meet weekly with a member of the honors staff in a class designed to prepare them for the facilitation experience and to monitor their progress. Open to all Honors students, subject to Program approval. Sophomore Honors standing required. Variable course content. Repeatable for up to eight credits. P/F only.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)
Repeatability: up to 8 credit hours

UH 4504 - Topics in Honors Discovery and Innovation Studios (3 credits)
Discovery and definition of critical, real-world problems. Transdisciplinary collaboration, design thinking, and experimentation. Reflective evaluation of individual and collective problem-solving efforts. Communication of solutions to diverse stakeholders. Variable course content. Repeatable for up to 12 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

UH 4514 - Honors SuperStudio (1 credit)
Transdisciplinary collaboration. Identifying and defining public/civic issues. Framing and strategizing transdisciplinary solutions to public/civic problems. Reflecting on transdisciplinary processes. Identifying and reflecting on issues of ethics and equity in public/civic problem solving. May be repeated one time with different content for a maximum of two credit hours.
Corequisite(s): 4504 or enrollment in an approved disciplinary capstone course.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 2 credit hours

UH 4704 - Honors Studio+ (3 credits)
Transdisciplinary and trans-sector collaboration in technology innovation. Identifying, defining, and setting problems in technology innovation. Applying evaluative criteria for technology innovation — feasibility, viability, desirability, sustainability. Using design thinking to analyze and reflect on creative processes. Identifying, articulating, and reflecting on the ethical dimensions of collaborative technology innovation. Design Lab/Studio (2H, 2L, 3C)
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4855 - Calhoun Transdisciplinary Capstone Studio (3 credits)
Advanced study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 4855: Systems building; project leadership and management, including resource allocation and scheduling; team management; value propositions; project pitches. 4856: User experience; user testing; systems assessment, including feasibility, viability, desirability, sustainability, optimization, and integration; systems reflection and documentation. Design Lab/Studio.
Prerequisite(s): UH 3856
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4856 - Calhoun Transdisciplinary Capstone Studio (3 credits)
Advanced study of transdisciplinary, collaborative design processes to address real-world problems in technology innovation provided by clients from business, government, and nonprofit organizations. 4855: Systems building; project leadership and management, including resource allocation and scheduling; team management; value propositions; project pitches. 4856: User experience; user testing; systems assessment, including feasibility, viability, desirability, sustainability, optimization, and integration; systems reflection and documentation. Design Lab/Studio.
Prerequisite(s): UH 4855
Instructional Contact Hours: (2 Lec, 2 Lab, 3 Crd)

UH 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

UH 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

University Studies and Scholarship Support

Our Website (https://www.universitystudies.vt.edu/)

Phone: 540-231-8440

University Studies

University Studies under Academic Advising Initiatives serves the university community in several ways. The office administers the University Studies program for new undergraduate students who want to explore a variety of degree programs before they commit to one particular major. University Studies is a non-degree granting major for students to explore options before choosing their major. With the guidance of a professional academic advisor, students research the full range of degree programs related to their interests and design programs of study that meet graduation requirements while providing the academic flexibility to pursue whichever degree program they ultimately choose. University Studies serves as both the college and department for University Studies students, providing administrative services, dean's office services, and academic advising until the students enter a specific major.

University Studies advisors along with other professional advisors in Academic Advising Initiatives assists new and current students who intend to change majors due to personal decisions or academic difficulty. This service is called Transitional Advising. Advisors work with students in developing programs of study in pursuit of their new major. Any student can make an appointment with Transitional Advising here: https://student.advising.vt.edu/major-exploration/transitional-advising.html.

Beyond advising, the office also supports students on Pell Grants and certain scholarships to meet financial aid and academic requirements to annually renew their grant or scholarship. This program is called Scholarship Support. Student mentors provide support and assistance by educating students of the grant and scholarship requirements needed to renew each year and how to be academically successful to meet those requirements. Students receiving this scholarship support service also have an academic advisors specific to their major.

More information about University Studies is available here: https://www.universitystudies.vt.edu.

University Studies

University Studies is a major but it is not a degree-granting program. University Studies offers a structured advising program that provides students with the necessary support and strategies to investigate and compare academic disciplines so that they can make informed decisions about the degree programs they will pursue. Students can explore any major available at the university while completing course requirements toward a baccalaureate degree. To ensure that students graduate in a timely manner, University Studies requires all students to enter a specific degree program by the time they have earned 60 credits toward graduation (approximately the end of the sophomore year) or have attempted 72 hours.

Restricted Majors

University Studies students can pursue any major offered at the university; however, students should be aware that some majors are competitive for internal transfer. These programs have established specific criteria and application procedures that students must fulfill in order to be considered for internal transfer into the major. In general, these criteria require students to demonstrate proficiency in designated core courses and, for some programs, introductory major courses before they are eligible to apply. University Studies students enter and graduate from these restricted programs each year; however, since there is no guarantee of acceptance to these programs, students are encouraged to investigate alternative majors even as they prepare to enter a restricted program. More information about restricted majors is located here: https://www.registrar.vt.edu/dates-deadlines/Change_of_Major_Dates.html (https://www.registrar.vt.edu/dates-deadlines/Change_of_Major_Dates.html)

Academic advisors in the University Studies are familiar with internal transfer criteria and procedures for all restricted majors. Advisors will assist students in pursuing these requirements.

Pathways General Education

All undergraduate students at the university, regardless of their majors, are required to fulfill general education course requirements in English, mathematics, science, social science, humanities, etc. There is a standard set of these courses, Pathways to General Education, which all degree programs incorporate in their graduation requirements.

General Education requirements are typically completed in the freshman and sophomore years. Some majors are flexible with regard to which General Education courses can be used to fulfill degree requirements; other majors suggest specific major courses which can count towards specific General Education requirements. Academic advisors assist University Studies students in selecting courses that apply towards as many of the majors a student is considering as possible. Thus, students fulfill degree requirements for graduation while they are exploring majors and are usually able to graduate on time.

Typical First Year Program

Code	Title	Credits
First Semester		
First-Year Writing		
Mathematics		
Natural Science (lab-if required by intended major)		
Social Science		
Humanities/Elective/Major Specific Course		

Second Semester
First-Year Writing
Mathematics
Natural Science (lab-if required by intended major)
Social Science
Humanities/Elective/Major Specific Course

For University Studies students, as for most students at the university, the first year is primarily devoted to fulfilling Pathways to General Education requirements. Of course, University Studies students' programs of study vary depending upon the major or majors they are considering. Specific course selections are determined in individual consultation with an academic advisor.

Graduation Requirements

The requirements to graduate in a specific major are determined by the department and college conferring the degree. In general, students are required to have a minimum 2.0 overall grade-point average and a minimum 2.0 grade-point average in their major in order to graduate. The number of credit hours required for a baccalaureate degree varies from 120 to 156 hours, depending upon a student's major and degree program.

Dean's List

University Studies students who demonstrate academic excellence are named to the Academic Dean's List and are awarded a Dean's List certificate. Students must be enrolled in a minimum of 12 graded hours (A-F) and must achieve a 3.4 GPA or higher in the fall or spring term to qualify.

Pre-Professional Advising

Students who want to enter professional schools but who have not yet chosen an undergraduate major will find that the university offers a variety of degree programs that provide excellent preparation for advanced training in professional fields. Though some professional programs, such as medicine, dentistry, and veterinary medicine, require students to complete a minimum number of credit hours at the undergraduate level in chemistry, biology, mathematics, etc., professional schools do not dictate that students pursue specific undergraduate majors. A student can pursue almost any undergraduate degree and be competitive for admission to a professional program.

Global Education Office (Study Abroad)

Opportunities to study at institutions in other countries are available to all qualified students, regardless of their major. Study abroad offers students a unique opportunity to learn about other cultures and peoples while earning college credit. Students who intend to participate in an overseas study experience should discuss their intentions with their advisor early in their academic career.

Director: L. Thomas

Associate Directors: N. Schwab and D. Trask,

Assistant Directors: A. Silknetter, C. Takacs, and H. Whedbee

Academic Advisor and Student Support Specialists: J. Chatham, J. Daniel, H. Goetz, and J. Johnson

Project Coordinator: L. Perry

Veterinary Medicine

Our Website (http://www.vetmed.vt.edu)

Overview

Founded by the Virginia General Assembly in 1978, the Virginia-Maryland Regional College of Veterinary Medicine is a regional school for the professional training of veterinarians which has been built upon the strong foundations of two of the nation's leading land-grant universities: Virginia Tech in Blacksburg and the University of Maryland at College Park. The College operates three campuses, including the main campus facilities at Virginia Tech, the Virginia Tech Animal Cancer Care and Research Center in Roanoke, VA, the Avrum Gudelsky Veterinary Center at College Park, and the Marion duPont Scott Equine Medical Center in Leesburg.

Graduate Program

The graduate program leads to the M.S. and Ph.D. in biomedical and veterinary sciences. The goal of this program is to enhance the research capabilities of the graduates so that they can conduct independent research and associated societal endeavors aimed at solving biomedical problems related to veterinary medicine. These individuals will be expected to make scientific contributions in academia, research, and animal health administration.

For additional information, contact the Graduate School via e-mail at cvmgrad@vt.edu.

Web: https://bmvs.vetmed.vt.edu/.

Professional Program

The veterinary program offers a four-year, full-time program leading to the Doctor of Veterinary Medicine degree. Our integrated curriculum includes classroom and laboratory instruction in the first two years and early immersion in clinical rotations, followed by more-advanced classroom instruction and additional clinical rotations.

Students desiring admission to the four-year instructional program leading to the D.V.M. degree must show evidence of intellectual ability and achievement, as well as personal preparation for the curriculum and the profession. Because the number of applicants greatly exceeds the number of spaces in entering classes, only those who demonstrate such qualifications to a high degree will be selected. Most entering students will have completed three or more years at an accredited university by the time of matriculation; however, applications will be accepted from students who have completed at least 60 semester hours or 90 quarter hours of university credit by the end of the spring term of the year for which application is being made.

A number of college courses, both science and humanities, are required for application to the veterinary professional program. In addition, other professional skills are essential for success not only within the program, but in life after graduation. These skills include communication, problem-solving and critical thinking.

Since veterinary medicine also is concerned with a variety of social, environmental, and community activities, a broad cultural background is important.

Admissions inquiries should be directed to:

Mrs. Shelby Stegall - Admissions Coordinator

Admissions Office
Virginia-Maryland Regional College of Veterinary Medicine
Virginia Tech
Blacksburg, VA 24061
Phone: (540) 231-4699
E-mail: dvmadmit@vt.edu
Web: www.vetmed.vt.edu (http://www.vetmed.vt.edu)

Public Health Program

Virginia Tech's Public Health Program in the Department of Population Health Sciences is administered by the Virginia-Maryland College of Veterinary Medicine in partnership with the Virginia Tech Carilion School of Medicine and is accredited by the Council on Education for Public Health. The Public Health Program offers both undergraduate and graduate degrees in public health.

Undergraduate programs in public health include the Bachelor of Science in Public Health degree and an undergraduate Minor in Public Health. At the graduate level, programs include the Master of Public Health, which can be pursued as a standalone degree program, combined with another graduate degree program (e.g., DVM, MD, PhD, MS, MA), or pursued as an accelerated undergraduate to MPH degree for exceptional Virginia Tech undergraduate students from any major. Additionally, the program offers an online Graduate Certificate in Public Health.

As a whole, the Public Health Program emphasizes a One Health approach to address local and global public health concerns. The One Health concept recognizes that the health of people is connected to the health of animals and the environment. Recognition of the dynamic interdependence of human, animal, and environmental health promotes interdisciplinary collaboration among medical, veterinary, public health, and other professionals. Students gain the requisite knowledge and skills to examine the human, animal, and environmental factors that contribute to the control and prevention of disease and the promotion, enhancement, and maintenance of health. Additionally, the program is committed to addressing public health challenges and opportunities facing Central Appalachia and other areas in Southwest and Southside Virginia. These regions have a rich cultural tradition, wisdom and significant community assets while at the same time facing high rates of unemployment, poverty and limited access to health care. The program's emphasis on rural health stretches beyond regional communities into other rural areas in Virginia, the nation, and beyond.

For additional information, please contact the Public Health Program at phs@vt.edu or by phone at (540) 231-3945.

- Public Health Major (p. 1385)
- Public Health Major with Pre-Medical Professions Option (https://catalog.vt.edu/undergraduate/veterinary-medicine/public-health-major-pre-medical-professions-option/)
- Public Health Major with Pre-Veterinary Professions Option (https://catalog.vt.edu/undergraduate/veterinary-medicine/public-health-major-pre-veterinary-professions-option/)

Dean: M. Daniel Givens
Interim Associate Dean for Professional Programs: Sunshine Lahmers
Associate Dean for Research and Graduate Studies: S. Ansar Ahmed
Assistant Dean for Administration: April G. Hylton
Associate Dean: Xiaoping Zhu
Professors: M. Borgarelli, V. A. Buechner-Maxwell, S. G. Clark, L.A. Dahlgren, G. B. Daniel, M. F. Ehrich, J. L. Hodgson, L. Hungerford, O. I. Lanz, M.L. Larson, M. S. Leib, M. Lee, D. Lindsay, H.C. McKenzie III, X. J. Meng, U. Pal, D. L. Panciera, K. D. Pelzer, J. P. Pickett, S. Pleasant, K. Redican, J. H. Rossmeisl, M. Seleem, S. A. Smith, D. P. Sponenberg, N. Sriranganathan, W. S. Swecker Jr., N. Tablante, N. A. White II, L, Yuan, X. Zhu and K.L. Zimmerman
Associate Professors: I. C. Allen, O. Balogh, L.E. Bartl, J. Barrett, G. Belov, A. S. Bertke, D. Blodgett, C. Byron, F. Carvallo-Chaigneau, C. Caswell, T. Cecere, B.J. Conner, J. L. Davis, N. G. Dervisis, F. Elnady, L. E. Freeman, J. M. Gohlke, D.C. Grant, P. N. Henao Guerrero, J. Q. He, I. P. Herring, K. Hosig, W. R. Huckle, S. L. Klahn, B. G. Klein, K. Lahmers, S. M. Lahmers, Y. W. Lee, X. Luo, D. Moore, N. Nanthakumar, D. Nelson, Y. A. Pan, J. Patton, P. Pithua, R. Ramierez-Barrios, G. Saunders, W. K. Scarratt, M. Shi, B. J. Smith, M.H. Theus, S. G. Witonsky, H. D. Xie, and Y. Zhang
Associate Professors of Practice: T. Burns, J. Pelzer and V. Ragan
Assistant Professors of Practice: S. Wenzel
Assistant Professors: K. Abbas, I. Athanasiadi, C. Baker, S. H. Barrett, T. Bolton, R. Calder, B. Ciepluch, A. Cohen, N.E. Cook, L. L. Corcoran, V. K. Corrigan, C. Deagle, S. M. DeMonaco, N. Duggal, S. L. Farris, M. Freeman, R. Gaji, M. Ghanem, T. E. LeCuyer, S. McDonald, G. Menicotti, P. D. Morton, D. Nelson, V.V. Paranjape, R. Parker, N. Rancilio, S. Riley, C. Rist, N. Ruktanonchai, Z. Sheng, M. Shi, R.L. Shinn, A. Smith, J. Stewart, S. A. Swanger, J. Tuohy, J.D. Weger, A. Wilkinson and J. Zambriski
Research Professor: K. A. Horn
Research Associate Professor: A.A. Bandara, W. Eyestone, R. L. Shinn
Research Assistant Professors: I. Akhrymuk, R. Dai, J. M. Green, S. Kenney, W. Li, M. R. Prater, C. Reilly, B. Rzigalinski, K. Sunil, E. Viktorova, S. Werre and X. Yang
Research Scientist: N. Evans, W. Li and R. Silverman
Clinical Associate Professors: L.E. Bartl, K. Boes, F Carvallo-Chaigneau, J. Cecere, J. F. Currin, M. Erskine, R.A. Funk, S.L. Klahn, T. LeRoith, M.T. Nappier and K.E. Wilson
Clinical Assistant Professors: M. Norris Adams, S. Barrett, S. Bogers, J. A. Brown, M.K. Byrnes, K. Estell, S.R. Guynn, A. Keebaugh, M. Kelleher, K. Murakami, D. R. Reeder, R. M. Rodriguez Galarza, D.N. Sawyere, M. Shepherd, H. Schramm, H. Tham and F.A. Wilkinson
Clinical Instructors: A.U. Arendse; C. Bowden, M. Brookhart, R. Carpenter, A.C. Figueiredo, M. Greer, E. MacDonald, V. Oakes, E. Schaeffer and L. Trager
Anatomy Instructor: T. Gillian
Adjunct Faculty: R. Anandakrishnan, J. Bahamonde-Azcuy, I. Becvarova, C. Bissett, M. J. Bowen ,C. Broaddus, M. Byrnes, B. Costa, M. V. Crisman, L. Crofton, S. Eubank, R. Gourdie, J. C. Gutierrez Toro, Q. Han, Y. Huang, T. Hrubec, T. Johnson, J. C. Jones, L. Kang, T. M. Kerkering, L. Lee, N. M. Lindstrom, K. MacDonald, R. MacPhail, C. J. McNeill, D.L. McRurer, P. Michalak, J. Moody, S. L. Porter, R. Prater, G. Rajagopalan, S. Rao, C. Reilly, B. Robert, A. Sage, S. Santamaria, K. Scarratt, S. Schwartz, J. Sleeman, S. J. Stahl, M. L. Tilghman, L. Tobias, R. Varghese, J. Walters and J. Weisman

Biomedical Science and Pathobiology (BMSP)

BMSP 2135 - Human Anatomy & Physiology (3 credits)
Structure and function of the human body for students preparing for professions in the health fields. 2135: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2136: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2135-2136 duplicates BIOL 2405-2406; may not receive credit for both.
Prerequisite(s): (BIOL 1005 or BIOL 1006) or (BIOL 1105 or BIOL 1106) or (BIOL 1205H or BIOL 1206H)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMSP 2136 - Human Anatomy and Physiology (3 credits)
Structure and function of the human body for students preparing for professions in the health fields. 2135: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2136: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2135-2136 duplicates BIOL 2405-2406; may not receive credit for both.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMSP 2145 - Human Anatomy and Physiology Laboratory (1 credit)
Laboratory exercises investigating the structure and function of the human body for students preparing for professions in the health fields. 2145: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2146: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2145-2146 duplicates BIOL 2414; may not receive credit for both.
Corequisite(s): BMSP 2135
Instructional Contact Hours: (3 Lab, 1 Crd)

BMSP 2146 - Human Anatomy and Physiology Laboratory (1 credit)
Laboratory exercises investigating the structure and function of the human body for students preparing for professions in the health fields. 2145: body plan and organization, homeostasis, cell structure and function, histology, integumentary system, skeletal system, muscular system, nervous system and special senses. 2146: endocrine system, circulatory & cardiovascular system, lymphatic system and immunity, respiratory system, digestive system, metabolism, excretion, reproduction, and development. BMSP 2145-2146 duplicates BIOL 2414; may not receive credit for both.
Corequisite(s): BMSP 2136
Instructional Contact Hours: (3 Lab, 1 Crd)

BMSP 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMSP 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

Biomedical and Veterinary Science (BMVS)

BMVS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4014 - Animal Domestication and Genetic Resources (1 credit)
Considers the process, history, sociology and geography of animal domestication. Includes behavioral, physiologic and morphological changes incurred by domesticated stocks. Examines genetic variability of domestic species, considers breed groups and uniquely adapted breeds. Considers reasons for erosion of genetic variability and mechanisms to counteract such erosion. International in scope. Pre: senior status or enrollment in veterinary professional curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 4024 - Diseases of Poultry (2 credits)
Biology control and prevention of poultry diseases. Taught alternate years.
Instructional Contact Hours: (2 Lec, 2 Crd)

BMVS 4054 - Laboratory Animal Management (3 credits)
This course involves a study of the principles of laboratory animal science, providing the student with a basic understanding of the laws and regulations governing the care and use of animals, husbandry and surgery of a variety of lab animal species, and variables which can adversely affect animal research. Through formal lectures, discussions, and laboratory sessions, the course is designed to complement graduate studies in biological, biomedical, and life sciences which involve the use of animals in research.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

BMVS 4074 - Pharmacology (3 credits)
A basic course in the science of pharmacology, intended to provide an understanding of the mechanisms of action and physiological systemic effects of major classes of drugs of biological, agricultural, social, and medical importance. Must have prerequisites or equivalent.
Prerequisite(s): CHEM 2514 or CHEM 2535 or ALS 2304 or BIOL 2406
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 4994H - Undergraduate Research (1-19 credits)
Honors section
Instructional Contact Hours: Variable credit course

BMVS 5005 - Emerging Infectious Diseases (1 credit)
Stand-alone, fully on-line, asynchronous distance and distributed learning course, accessible as streaming videos on the internet or on CDs. 5005: The course defines and discriminates amongst numerous factors influencing the emergence of infectious diseases. Selected emerging food-borne, bacterial, viral, zoonotic diseases of animals and humans are described and analyzed. 5006: The course expands the pathology of emerging infectious diseases. Additional viral, parasitic and zoonotic diseases of animals and humans are described and analyzed. Xenotransplantation is also discussed from the perspective of zoonotic diseases. Third year standing in the DVM curriculum, or good standing in a graduate studies program is required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: VM 9085

BMVS 5014 - Animal Pathology Residency (1-5 credits)
Training in diagnostic pathology through weekly rotations in the necropsy and surgical biopsy service of the teaching hospital. Students will perform necropsies and histopathologic examinations of necropsies and surgical biopsies and write diagnostic reports. The course is taken in weekly intervals of necropsy and/or surgical biopsy, with a credit hour given for each 2-week interval. Variable credit. May be repeated with a maximum of 5 hours. DVM degree required.
Instructional Contact Hours: (15 Lab, 1-5 Crd)
Repeatability: up to 5 credit hours

BMVS 5094 - Grant Writing and Ethics (3 credits)
A framework for writing clear, concise grant proposals in a team-oriented, multidisciplinary approach from concept development through submission to a funding agency. Potential ethical dilemmas that may arise in academic, industrial, or federal research settings will be discussed. PRE: Undergraduate courses in one of the following: organic chemistry (CHEM 2565/2566), cell and molecular biology (BIOL 2104), Concepts of Biochemistry (BCHM 2024), or equivalent. Graduate standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CHEM 5094, FST 5094

BMVS 5114 - Critical Skills in Biomedical Research (3 credits)
This course is intended to reach a broad population of students in biological/biomedical research programs and help them develop critical skills in analytical thinking and scientific communications. The course contents include reviews of past and current conceptual advancement, technology development, and controversial topics, in contemporary biomedical research, including but not limited to molecular & cellular biology, genomics, neurobiology, and cancer. The course also includes in-depth analyses of experimental designs and data interpretations, and important considerations for the appropriateness and limitations of experimental approaches and models. This course may be repeated up to 1 time for a total of 6 credit hours. Pre: Biochemistry, Molecular Biology, or equivalent.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 6 credit hours

BMVS 5124 - Reproductive Pathology (1 credit)
Study of lesions of the reproductive system of domesticated animals. Relationship of these lesions to infertility and examination of the pathogenesis of the lesions and infertility.
Prerequisite(s): ALS 4304
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: VM 8474

BMVS 5174 - Responsible Research Conduct (1 credit)
Scientific integrity and responsible conduct of research as related to studies in life sciences, physical sciences, social sciences, engineering, and humanities. Conflict of interest, human and animal subjects in research, mentor/mentee responsibilities, collaborative research, peer review, research misconduct, responsible authorship and publication, data management, sharing, and ownership, and legal issues in research. Pre: Graduate Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 5194 - Clinical Micropathology (1 credit)
This course presents practical topics in diagnostic pathology. It covers the entire spectrum of disease processes, including the background of clinical, gross anatomic physiologic information required for integration with the microscopic changes observed to arrive at a correct diagnosis. DVM degree and permission of the instructor required.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 5224 - Biomedical Engineering and Human Disease (3 credits)
Comprehensive overview of a variety of human diseases, including neurological disorders, cardiovascular disease, infectious disease, and cancer, designed primarily for graduate students majoring in engineering and other related areas who have a long-term academic and professional goal in the field of biomedical engineering and life sciences. Introduction to state-of-the-art biomedical engineering approaches used for the study of early detection/diagnosis, treatment and prevention of human disease. Graduate standing required.
Prerequisite(s): BMES 5004 or BMVS 4064 or BMES 4064
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: BMES 5024

BMVS 5244 - Veterinary Pharmacology (1-5 credits)
Principles of pharmacodynamics and pharmacokinetics, including interaction of drugs with receptors; absorption, distribution and clearance; drug metabolism and drug interactions. Study of drugs by pharmacological classes, the general mechanisms of action, usefulness and side effects. Pharmaceutical calculations and prescription writing. May be repeated for a maximum of 5 credits. Pre-requisite: Graduate standing required
Instructional Contact Hours: (1-5 Lec, 1-5 Crd)

BMVS 5274 - Systems Pathology (3 credits)
This lecture only course covers the pathology and pathogenesis of specific lesions and diseases of each organ system at the gross and microscopic level. Emphasis is on diagnostic characteristics and interpretation of diseases. Pre: DVM or equivalent.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 5284 - Cellular Pathology (3 credits)
This course presents the mechanisms involved in cellular reaction to injury, inflammation, tissue repair and regeneration, circulatory disturbances (thrombosis, embolism, infarction, hemorrhage, edema, congestion, shock) and neoplasia and other alterations of cell growth. Emphasis will be placed upon disease processes at the cellular and tissue levels.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 5324 - General Neurochemistry (3 credits)
Biochemical mechanisms involved in normal and abnormal nervous system function including discussions of experimental techniques, structural components, neurotransmitters, cerebral blood flow and metabolism, sensory systems, learning, mental disorders, and neuropharmacological agents.
Prerequisite(s): (BCHM 4116 or BCHM 5124) or (BCHM 4116 or BCHM 5124)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 5564 - Introduction to Clinical Research (2 credits)
Design of studies in veterinary related clinical research, planning and implementation of experimental and survey data collection, management and analysis of data, evaluation of analysis and critical evaluation of published information. Instructor approval required.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: VM 8534

BMVS 5574 - Advanced Poultry Diseases (3 credits)
An advanced course covering diagnosis, etiology, and treatment of poultry diseases. Diseases will be grouped by system affected, their common features detailed, and then unique characteristics of these diseases described.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 5594 - Current Technologies in Biomedical Sciences (1 credit)
Current methodologies and techniques for hypothesis-driven scientific experimentation in biomedical research, including molecular biology approaches, microscopy, animal models, molecular applications, cell culture systems, large-scale omics methodologies, bioinformatics analyses, and clinical studies. Cutting-edge and novel approaches for designing experiments and interpreting the resulting data; review of scientific literature; and important considerations for the appropriateness and limitations of specific methods, approaches, and experimental models. Pre: Graduate standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 5624 - Molecular Virology (2 credits)
The principles and mechanisms of virus replication at the molecular level including transcription, translation and posttranslational modifications of virus genes, virus interaction with host, antivirals, vaccines and host defense mechanisms against virus infections. The replication and pathogenesis mechanisms of several important DNA and RNA virus families including biothreat viruses. Graduate standing required.
Instructional Contact Hours: (2 Lec, 2 Crd)

BMVS 5704 - Veterinary Cytopathology (1 credit)
Interpretation of cytopathologic samples. Descriptive reports. Routine to complex case material from animal tissue specimens. Prerequisite: Third year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 5764 - Aquatic Medicine and Fish Health (2 credits)
The etiology, diagnosis, pathology, pathogenesis, chemotherapy, control and management of infectious and non-infectious diseases of aquatic organisms, especially pertaining to cultured food and tropical fish. Hands on experience with water quality evaluation, diagnostic techniques and the identification of common pathogenic organisms. Pre-requisite: Second year standing in the DVM curriculum.
Prerequisite(s): VM 8364 or FIW 4514
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: VM 8494

BMVS 5794 - Clinical Neuropathology (1 credit)
This course uses necropsy tissues of clinical cases to present the mechanisms involved in neurologic disease of animals. Gross, microscopic, and radiologic approaches will be employed. Emphasis will be placed upon the correlation of clinical and pathological findings. May be repeated. Pre: Instructors approval required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 4 credit hours

BMVS 5814 - Functional Morphology and Natural History of Reptiles and Birds (1 credit)
Anatomical features will be described that are unique to, or are characteristic of, each major group covered. Adaptation and successful exploitation of habitat. Use of anatomical features and functions. Selected attributes of the groups natural history, members of the group common to the local and extended area, those commonly kept as pets. Pre-requisite: Graduate Standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: VM 8254

BMVS 5894 - Final Examination (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 5904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 5944 - Seminar in Biomedical and Veterinary Sciences (1 credit)
Presentations by graduate students on current topics in Biomedical and Veterinary Sciences. Topics and responsibility for seminars is rotated among the professional departments of the college. Maximum 4 credits.
Instructional Contact Hours: (1 Lec, 1 Crd)

BMVS 5954 - Study Abroad (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 5974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 5984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 5994 - Research and Thesis (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 6014 - Veterinary Clinical Sciences Residency (0 credits)
Advanced course with training and instruction in veterinary patient management. Supervised practicum in veterinary diagnosis and therapy in a veterinary teaching hospital. Material will include development of knowledge and skills for problem solving, performance of techniques, and effective communication. Regularly scheduled rounds and conferences will supplement daily activities. 0 credit. DVM degree required.
Instructional Contact Hours: (0 Lec, 0 Crd)

BMVS 6064 - Advanced Topics in Veterinary Medicine (1-6 credits)
Students will critically review and actively participate in discussion of current and important historic veterinary and comparative medical literature relevant to students residency specialty. DVM degree is required. May be repeated with different content for a maximum of 12 credit hours.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 12 credit hours

BMVS 6074 - Clinical Topic Rounds (1-6 credits)
Practical, advanced training in specialty medicine. Students will participate in critical reviews of cases and current literature applicable to selected cases. Relevant information will include advanced diagnostic and therapeutic techniques applicable to the specialty and species being studied. An in-dept knowledge of the pathophysiology of animal disease processes and clinical problem solving will be developed. Students will be expected to gain an understanding of the general problem area to be studied and critically evaluated current literature and application to the case(s) being studied. DVM degree is required. May be repeated with different content for a maximum of 12 credit hours.
Instructional Contact Hours: (1-6 Lec, 1-6 Crd)
Repeatability: up to 12 credit hours

BMVS 6084 - Veterinary Speciality Clinics (3 credits)
Practical, advanced training in specialty medicine. Students will learn advanced diagnostic and therapeutic techniques applicable to the specialty and species being studied. An in-depth knowledge of the pathophysiology of animal disease processes and clinical problem solving will be developed. Students will be given responsibility for case management with faculty guidance. DVM degree is required. May be repeated for a maximum of 12 credits with different content.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 12 credit hours

BMVS 6094 - Board Certification Topics (1 credit)
Structured preparation for the specialty examinations associated with residency programs and board certification. Topics will vary depending on the particular learning objectives required by the clinical discipline. Pre-requisite: Graduate standing and clinical resident in the Virginia Maryland Regional College of Veterinary Medicine. May be repeated for up to 6 credit hours with different content.
Instructional Contact Hours: (1 Lec, 1 Crd)
Repeatability: up to 6 credit hours

BMVS 6114 - Neurogenesis in the Developing and Diseased Brain (3 credits)
Development, maintenance and injury-induced response of stem cells in the brain. Key epigenetic and signal transduction pathways required for the proper development and adaptive response of stem cells in the neurogenic compartments after brain injury in rodents and larger animal species.
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 6534 - Mechanisms of Disease in Veterinary Medicine (3 credits)
Advanced study of topics concerning the pathophysiology, diagnosis, and current therapy of diseases in Veterinary Medicine. Pre: DVM or equivalent, or consent of instructor. May be repeated to a maximum of 18 credits.
Instructional Contact Hours: (3 Lec, 3 Crd)
Repeatability: up to 18 credit hours

BMVS 6714 - Immunology in Health & Disease (3 credits)
Analysis of emerging, cutting edge and paradigm changing concepts of cellular and molecular immunology in human and animal health and disease. Innate immunity, adaptive immunity, developmental immunology, autoimmunity, immunodeficiency, cancer immunology, and transplantation immunology.
Prerequisite(s): BIOL 5734 or BCHM 5124
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 6724 - Mol Mech of Path Bacteria (3 credits)
Molecular mechanisms employed by pathogenic bacteria to cause infection. Classical and contemporary methods for studying host-pathogen interactions at the molecular level. Hypothesis-driven scientific experimentation in pathogenic bacteriology.
Prerequisite(s): BIOL 5634 or BIOL 5674
Instructional Contact Hours: (3 Lec, 3 Crd)

BMVS 6984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

BMVS 7994 - Research and Dissertation (1-19 credits)
Instructional Contact Hours: Variable credit course

Population Health Sciences (PHS)

PHS 1004 - Public Health First Year Experience (1 credit)
Introduction to the Department of Population Health Sciences and the Public Health curricula requirements. Introduces students to experiential learning opportunities, undergraduate research, ethical behaviors and career paths within the discipline. Exploration of programs, services and resources to enhance awareness of opportunities and support systems available for student success including academic advising and career planning. Intended for Public Health majors in their first semesters at Virginia Tech, either as incoming freshmen or transfer students.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 1514 - Personal Health (3 credits)
Fundamental health content and theory to provide students with constructive health information necessary to meet current and future personal health needs. Special emphasis on wellness and health promotion.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 1984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2004 - Introduction to Public Health (3 credits)
Examination of how public health core disciplines of epidemiology, health policy and administration, health behavior, and environmental health work together in addressing public health problems. Special emphasis on the history of public health, the public health infrastructure and role of health informatics in public health.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 2974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 2994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 3014 - Introduction to Environmental Health (3 credits)
Overview of environmental health, examining local, national, and international frameworks. Environmental factors that affect human health, including major classes of chemical, biological, and physical exposures from different environmental media (air, water, food, and soil). Special emphasis on toxicology and epidemiology methodologies used at the individual (mechanistic) level and at the population level to determine environmental causes of disease. Find the most appropriate prevention or control measure to minimize adverse health outcomes.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3044 - Global Health Issues (3 credits)
Students will get an overview of the determinants of health and how health status is measured. Students will also review the burden of disease, who is most affected by different disease burdens, risk factors, and key measures to address the burden of disease in cost-effective, doable, sustainable, and fair ways. Special attention will be paid throughout the course to health systems issues. The course will cover key concepts and frameworks but be practical in orientation. The course will be global in coverage but will focus on low- and middle-income countries, the health of the poor, and health disparities. The course will pay particular attention to the linkages between health and development. Pre: Junior standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3064 - Public Health Seminar (1 credit)
Current topics in public health research, policy and practice, including biostatistics, epidemiology, health policy, environmental health, social and behavioral medicine, infectious diseases, and public health education. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 3074 - Public Health Practicum Prep (1 credit)
Preparation for the public health profession and practicum experience. Covers the necessary skills to become a successful public health professional. Students will explore and prepare for the public health practicum course by assessing interests, identifying placement opportunities, and completing necessary placement materials. Communication, ethical considerations, professional skills along with the development of resume/CV, cover letters, interviewing and networking will be covered. P/F only. Pre: Junior Standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 3534 - Drug Education (3 credits)
Interpretation of multidimensional (social, psychological and physiological) scientific data regarding drugs. The major drug categories will be covered with special emphasis on substance misuse and abuse.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3634 - Epidemiologic Concepts of Health and Disease (3 credits)
Designed to give students in the health sciences a basic understanding of the modern concepts regarding health and disease as well as skills in organizing epidemiological data, disease investigation and surveillance. Includes a survey of terms, concepts, and principles pertinent to epidemiology. Lifestyles of populations and the relationships between lifestyles and health status are studied.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 3634

PHS 3654 - Equity in Rural Health (3 credits)
Exploration of the socioeconomic, behavioral, biological, environmental and other factors that impact human health and contribute to health disparities. Introduction to concepts surrounding rural health equity, including: (i) defining rurality; (ii) identifying social determinants of health; (iii) reviewing the history of the US public health systems and policies tasked with improving rural health; (iv) describing critical health disparities impacting rural communities (such as cardiovascular disease, cancer, mental health and substance use disorders), and the drivers of these disparities; and, (v) (v) assessing health of special populations living in rural communities, such as maternal, newborn, adolescent and child health, aging populations, migrant populations, and LGBTQ + populations (vi) discussing the assessment, planning, policies, and interventions which can be implemented to improve the health of rural communities at the population level.
Prerequisite(s): PHS 2004
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 3964 - Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 3984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4014 - Public Health Program Planning and Evaluation (3 credits)
Fundamental of public health program development, implementation and evaluation. Basic processes, approaches and interventions that identify and address the major health-related needs and concerns of populations. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4044 - Public Health Policy and Administration (3 credits)
Evolution and analysis of public health policy in the United States. Public health and care systems. Administrative concepts central to public health such as human resources, strategic planning, controlling, directing, leadership and health law. Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4054 - Concepts in One Health (3 credits)
Dynamic interdependence of human, animal and environmental health; theoretical foundations of One Health; One Health research methods for assessing animal-human linkages; One Health operationalization in human medicine, veterinary medicine and public health; policies and practices related to One Health; and capacity building and public engagement; One Health and traditional Medical Model approaches to health problems. Pre: Junior standing.
Pathway Concept Area(s): 3 Reasoning in Social Sciences, 4 Reasoning in Natural Sci., 11 Intercultural&Global Aware.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4064 - Modeling Infectious Diseases (3 credits)
Mathematical modeling of infectious diseases; simple epidemic models, risk structure and modeling risk structure, multi-pathogen models, multi-host models, temporal seasonal models, spatial models, stochastic dynamics and modeling for public health policy. Pre: Junior Standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 4074 - Practicum in Public Health (2 credits)
Application of Public health theories, concepts and data in a work setting; comprehensive, structured experience requires student to demonstrate professional competencies and ethical behavior while working closely with a supervisor in a public health practice setting. Pass/Fail Only. Pre: Senior standing.
Prerequisite(s): PHS 3074
Instructional Contact Hours: (2 Lec, 2 Crd)

PHS 4094 - Appalachian Community Research (3 credits)
Undergraduate participatory community research as applied to issues of cultural heritage, sustainability, and identity. Students engage in projects defined by community groups and organizations as being critical to their well-being, continuity, or growth. Emphasis is on developing concepts of civic professionalism and developmental democracy.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: APS 4094, SOC 4094

PHS 4974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4974H - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4994 - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 4994H - Undergraduate Research (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 5004 - Foundations of Public Health (1 credit)
Foundational principles of public health, including history, core functions and essential services. Public health ethics and values. Career opportunities in the public health core disciplines. Biologic determinants of health. Global and One Health frameworks for health and health professionals. Pre: Graduate standing.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 5014 - Environmental Health (3 credits)
Exploration of major environmental health concepts and issues, environmental policies and regulations. Topics include world population and pressures on the environment, healthy environment; environmental determinants of public health, including biological, physical and chemical factors; environmental factors affecting disease vectors and their control; air and water quality; waste management; the built environment, work environments and recreational area; food protection and safety; occupational health; tools for environmental evaluation, planning and safety. Pre: Graduate Standing or permission from the instructor.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 7014

PHS 5024 - Epidemiology and Quantitative Methods in Public Health Lab (1 credit)
Statistical skills needed to conduct epidemiologic and public health research including descriptive statistics, bivariate statistics, and regression. Reading and writing code. Manipulate, analyze, and visualize public health data using statistical software. Probability, confidence intervals, and significance. Statistical power. Pre: Graduate standing.
Corequisite(s): PHS 5026
Instructional Contact Hours: (3 Lab, 1 Crd)

PHS 5025 - Epidemiology and Quantitative Methods in Public Health (3 credits)
5025: Investigation and analysis of dynamics and determinants of disease in communities and populations. Philosophy, assessment, and application of public health science, ethics, study design, data analysis, and epidemiologic measures. 5026: Basic ideas, methods, and measures of epidemiology. Statistical knowledge and skills to analyze and interpret data from epidemiologic studies. Introduction to common statistical packages. Evaluation of scientific evidence from literature. Identify and minimize major potential sources of error in epidemiologic studies. Pre: Graduate standing for 5025.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5026 - Epidemiology and Quantitative Methods in Public Health (3 credits)
5025: Investigation and analysis of dynamics and determinants of disease in communities and populations. Philosophy, assessment, and application of public health science, ethics, study design, data analysis, and epidemiologic measures. 5026: Basic ideas, methods, and measures of epidemiology. Statistical knowledge and skills to analyze and interpret data from epidemiologic studies. Introduction to common statistical packages. Evaluation of scientific evidence from literature. Identify and minimize major potential sources of error in epidemiologic studies. Pre: Graduate standing for 5025.
Prerequisite(s): PHS 5025
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5034 - Health Behavior and Health Education (3 credits)
This course has two main purposes: (1) to familiarize students with historical, theoretical and methodological aspects of health psychology, and (2) to acquaint health education students with the social, psychological, and cultural determinants of health behaviors which form the underpinnings of health education practice.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5044 - Public Health Policy and Administration (3 credits)
Multiple dimensions of the health policy-making process including the roles of ethics and evidence. Analyzing health polices for their impact on public health and health equity. Examining the structure and function of health care models nationally and globally. Constitutional basis for public health. Applying principles of planning, organizing, directing, staffing, and budgeting to public health agencies. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 5694

PHS 5054 - Public Health Leadership and Interprofessionalism (2 credits)
Fundamentals of public health leadership and management using a systems-thinking lens. Decision-making, change management, shared vision, and communication. Strategic planning and public health ethics. Negotiation role-playing. Models of team effectiveness. Team building applied to working on public health and interprofessional teams. Collaborative leadership, personal leadership styles, and self-reflection. Diversity and cultural competency in the public health setting as a leader. Pre: Graduate standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

PHS 5064 - Public Health Program Development and Evaluation (3 credits)
Development and evaluation of public health education and infectious disease programs. Health equity, systems thinking, and cultural responsiveness throughout the program development and evaluation cycle. Assessment of community health needs. Engagement of diverse stakeholders. Effective public health program design. Development of evaluation plans to assess processes, outcomes, and impacts. Relationship between program development, ongoing evaluation, and improvement. Communication of evaluation findings to stakeholders. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 7064

PHS 5204 - Principles of Community Health Education (3 credits)
Public health issues and concepts are analyzed and evaluated in relationship to existing principles of health education.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5214 - Program Development in Health Education (3 credits)
Theory, trends, and design of community health education programs implemented in communities, health agencies, hospitals, and industry. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HNFE 5684

PHS 5224 - Comp Health Systems (3 credits)
Comprehensive examination of the structure and function of worldwide healthcare and public health systems. National health services with central funding, social insurance programs, decentralized systems, and private insurance systems. Pre-requisite: Graduate Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5234 - Methods of Community Health Engagement (3 credits)
This course is designed to present core concepts, models, methods, strategies and challenges in the process of working with communities to improve community-identified population health needs. This course presents an overview of models for community organizing and community capacity building and provides students the opportunity to apply classroom concepts "in the field" through working with community partners and the development and presentation of a group Needs Assessment in collaboration with the community partner. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5244 - Sexual Health and Human Rights (3 credits)
Sexual and reproductive health from human development, public health, and critical feminist perspectives, with special attention to human rights issues. Sexually transmitted infections; HIV/AIDS; unintended pregnancy; population policies; eugenics; sexual and reproductive rights; positive sexuality, sex education; and health promotion. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 5244, WGS 5244

PHS 5254 - Social Epidemiology and Health Inequities (3 credits)
Social determinants of health through the life-course. Relationship of social injustice to public health. Interplay of major social factors such as poverty, race and gender to influence health domestically and globally. Application of social epidemiology to a range of health outcomes. Inform effective solutions to health inequities. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: HD 5254

PHS 5314 - Infectious Disease Epidemiology (3 credits)
Dynamics and determinants of infectious diseases and their assessment on the molecular to population continuum in a systems based approach. Infectious disease transmission mechanisms; population susceptibilities; environmental, social, cultural and economic contributors to infectious disease propagation; detection and surveillance; geographic information systems; epidemiologic study design; and infectious disease modeling. Prerequisite: Graduate Standing required
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 7314

PHS 5324 - Pub Hlth Infect Contrl & Prev (3 credits)
Assessment, policies, and procedures for control and prevention of infectious diseases in communities and populations. Sources, transmission mode, and local community to international dissemination of infectious disease agents; antimicrobial and chemical resistance; vaccine development, safety, and coverage; community and hospital based needs and interventions; and regulatory frameworks. Pre: Graduate Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 9324

PHS 5334 - Principles of Infectious Diseases (3 credits)
Principles of infectious diseases important for local, national, and global public health. Bacterial, viral, fungal, and parasitic pathogens; mechanisms of disease; host immune response to pathogens. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 9334

PHS 5344 - Neglected and Emerging Infectious Diseases in Public Health (3 credits)
Neglected infectious diseases and their association with marginalized populations and factors including poverty, social and health inequities, water, sanitation and hygiene, and urbanization. Critical factors for emergence/re-emergence of infectious diseases in populations and regions, including geopolitical challenges, zoonotic and vector impacts. Evaluate studies and global responses to neglected and emerging infectious diseases to inform the development of One Health interventions. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: VM 9344

PHS 5704 - Drinking Water & Health (3 credits)
Drinking water contamination and associated health outcomes. Programs to improve safe water access. Viral, bacterial, protozoal, and helminthic pathogens. Heavy metals, pesticides, and other contaminants. Drinking water treatment and supply in rural areas. Study designs for health outcome assessment. Field-based intervention trials. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: CEE 5704

PHS 5714 - Health of the Elderly (3 credits)
The health needs and problems of the elderly, the implications for those working with the elderly, and possible health care delivery systems.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5724 - Ethical Foundations of Public Health (3 credits)
Methods for ethics decision-making in public health and health policy, exploration of theoretical foundations of ethical public health practice, methods for identifying ethical challenges and ethical dilemmas, skills for managing ethical ambiguity, differences and similarities between professional ethics, research ethics, clinical ethics, and public health ethics, key historical events in public health that led to ethical and policy requirements, decision-making frameworks to analyze public health ethical challenges, current writings in public health ethics literature, well-reasoned written and oral arguments for a course of action to address public health ethics dilemmas. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5904 - Project and Report (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 5914 - Practicum in Public Health (6 credits)
Public health theories and concepts in a work setting; comprehensive, structures experience requires student to demonstrate professional competencies while working closely with a supervisor in a public health practice setting. Pre-requisite: Graduate Standing and completion of 24 hours of MPH degree coursework.
Instructional Contact Hours: (6 Lec, 6 Crd)

PHS 5924 - Capstone in Public Health (3 credits)
Synthesis of coursework and practicum experience into a final comprehensive product which integrates knowledge and skills acquired in all core classes, specific MPH concentration courses and practicum experience for developing, implementing and evaluating a public health program; tests students ability to effectively analyze a public health problem and develop an intervention toward a solution to the problem. Pre-requisite: Graduate standing; completion of 39 hours of MPH coursework including enrollment in or completion of public health practicum.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5934 - Public Health Integrative Learning Experience (3 credits)
Culminating experience required for the MPH degree. Integration of program foundational and concentration-specific competencies. Team-based public health educational and professional experience. Addressing a public health challenge. Working with a mentor from an external stakeholder organization. Producing individual high-quality written deliverable. Reflection on the learning experience. Team presentation of project. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)

PHS 5935 - Preparation for Public Health Practice (1 credit)
Preparation for the public health profession. Covers the necessary skills to become a successful public health professional. 5935: Exploration of Public Health Practice Experience (PHPE) placement opportunities. PHPE goals, objectives, and competencies. PHPE products that align with academic and professional goals. PHPE learning contract. Institutional review board (IRB) protocols. Communications and professionalism skills. Academic poster and e-portfolio design. Work/life balance strategies. 5936: Examination of professional preparation for careers in public health. Job search strategies, resume/CV and cover letter writing, interviewing, and networking. Workplace skills, including professional communication, group process, leadership/supervision skills, working with the media, and survey design and data presentation. Personal/professional growth strategies, including salary and benefits negotiation, debt management, and time management. Grant writing. Pre: Graduate standing; 5935 for 5936. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 5936 - Preparation for Public Health Practice (1 credit)
Preparation for the public health profession. Covers the necessary skills to become a successful public health professional. 5935: Exploration of Public Health Practice Experience (PHPE) placement opportunities. PHPE goals, objectives, and competencies. PHPE products that align with academic and professional goals. PHPE learning contract. Institutional review board (IRB) protocols. Communications and professionalism skills. Academic poster and e-portfolio design. Work/life balance strategies. 5936: Examination of professional preparation for careers in public health. Job search strategies, resume/CV and cover letter writing, interviewing, and networking. Workplace skills, including professional communication, group process, leadership/supervision skills, working with the media, and survey design and data presentation. Personal/professional growth strategies, including salary and benefits negotiation, debt management, and time management. Grant writing. Pre: Graduate standing; 5935 for 5936. Pass/Fail only.
Prerequisite(s): PHS 5935
Instructional Contact Hours: (1 Lec, 1 Crd)

PHS 5964 - Practicum (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 5974 - Independent Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 5984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

PHS 8984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

Professional Program Courses

Professional program courses leading to the D.V.M. degree carry the veterinary medicine (VM) prefix. For updated information on the DVM Curriculum, please see our website at: http://www.vetmed.vt.edu/academics/dvm/dvm-curriculum.asp.

VM 7014 - Environmental Health (3 credits)
Exploration of major environmental health concepts and issues, environmental policies and regulations. Topics include world population and pressures on the environment, healthy environment; environmental determinants of public health, including biological, physical and chemical factors; environmental factors affecting disease vectors and their control; air and water quality; waste management; the built environment, work environments and recreational area; food protection and safety; occupational health; tools for environmental evaluation, planning and safety. Pre: Graduate Standing
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5014

VM 7064 - Public Health Program Development & Evaluation (3 credits)
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5064

VM 7314 - Infectious Disease Epidemiolog (3 credits)
Dynamics and determinants of infectious diseases and their assessment on the molecular to population continuum in a systems based approach. Infectious disease transmission mechanisms; population susceptibilities; environmental, social, cultural, and economic contributions to infectious disease propagation; detection and surveillance; geographic information systems; epidemiologic study design; and infectious disease modeling. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5314

VM 8000 - Small Animal Behavioral Medicine (1 credit)
Behavioral medicine of the dog and cat; ontogeny of behavior, basic obedience and housetraining, aggression, anxiety, compulsive disorders, elimination problems, psychopharmacology. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8004 - The Animal-Human Relationship (2 credits)
Exploration of the animal-human relationship and its impact on animal and human welfare. Five themes; animal cognition; animals in service roles, shelter medicine and management, animal laws, and wildlife-human interface. Communication of health-related topics to other professionals and general public. Pre: 3rd year standing in the DVM program. P/F only. Design Lab Studio
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 8020 - Equine Diagnostic Techniques for Digestive, Nervous and Integumentary System (1 credit)
Diagnostic and therapeutic techniques commonly used in equine practice involving the gastrointestinal, neurological and integumentary systems. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio (2L,1C)
Corequisite(s): VM 8030, VM 8696
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8024 - Descriptive Embryology (1 credit)
A brief introduction to the early stages of development in common domestic animals. Covers the period from fertilization of the oocyte to initiation of organogenesis. Also introduces concepts on the mechanisms of development and the teratogenic effects of exogenous factors. Includes an introduction to the phenomenon of multiple pregnancies in different species, and comparative patterns of placentation. This course provides an overview of the cellular events immediately preceding and following fertilization, as well as a synopsis of general developmental features of gastrulation, placentation, and ontogeny of selected body systems. Completion of the course should greatly assist students in understanding various anatomical aspects of the adult animal body, as well as common congenital malformations. Pre: first-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8030 - Special Topics in Equine Clinical Practice Lab (1 credit)
Clinical techniques for evaluation of the ophthalmological, neurological, odontological and gastro-enteric systems of horses. Techniques for preventive medicine of teeth. Castration and wound management. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8060 - Compassionate End of Life Care (2 credits)
Ethical implications and communication nuances regarding euthanasia of animals. Euthanasia techniques, mechanism of action of drugs, pre-anesthesia sedation and anesthesia protocols, routes of administration of euthanasia drugs and regulatory requirements of controlled substances including those in the American Veterinary Medical Association (AVMA) Guidelines for Euthanasia of Animals. Client bereavement, pet memorialization, after care services and compassion fatigue. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8070 - Fundamentals of Veterinary Diagnostics (2 credits)
Fundamentals of veterinary diagnostic testing. Application of diagnostic reasoning in test selection and result interpretation. Select test methodology in the major diagnostic areas. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8110 - Sensing and Seeing (10 credits)
Neural, ocular and cutaneous structure and function required for locomotion, vision, touch, and hearing. Diagnosis and treatment of common diseases of domestic animals that limit function of sensing and seeing. Normal and abnormal integument of domestic animals. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (8 Lec, 3 Lab, 10 Crd)

VM 8130 - Special Topics in Equine Problem Solving (2 credits)
Application of clinical reasoning skills to diagnose, treat and manage diseases of horses involving the gastrointestinal, nervous, reproductive, ocular and integumentary systems. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8154 - Food Animal Product Safety for Veterinarians (2 credits)
History, development and enforcement of laws and regulations that affect the food animal processing industry and consumers of animal products. Comprehensive approach to microbiological and physical foodborne hazard identification, testing and sampling. Foodborne hazard prevention and control, including Hazard Analysis and Critical Control Points systems. Pre-requisite: Third year standing in DVM curriculum
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8164 - The Normal Animal (10 credits)
Normal individual behavior, social behavior, and management of domestic species. Normal domestic animal body structure and function including skeletal and neuromuscular organization, body cavities and gross and radiographic anatomy of structures within those cavities. Foundational knowledge of cell structure, differentiation and physiology, pharmaceuticals that influence cellular physiology. Clinical Skills required for veterinarians. Pass/Fail Only. Pre: Graduate Standing.
Instructional Contact Hours: (8 Lec, 4 Lab, 10 Crd)

VM 8174 - Dealing with Threats (10 credits)
Bacterial, viral, parasitological, toxicological agents of disease in domestic animals; mechanisms of disease production. Immunological responses to infectious agents and immune-mediated diseases. Pathological and clinic- pathological responses of domestic species to insult. Principles of epidemiological evaluation, diagnosis, treatment, control and prevention of common threats to domestic species. Pass/Fail Only.
Instructional Contact Hours: (8 Lec, 6 Lab, 10 Crd)

VM 8194 - The Next Generation (9 credits)
Anatomy, physiology, pharmacology and medical aspects associated with conception, embryonic and fetal development, gestation, delivery, and lactation, as well as neonatal development, disorders and management. Surgical and medical management of fertility will also be covered, to include hands-on surgical experience performing canine ovariohysterectomy. Pass/Fail only.
Instructional Contact Hours: (7 Lec, 6 Lab, 9 Crd)

VM 8204 - Healthy Populations (7 credits)
Principles of epidemiology, biosecurity, population dynamics preventative health management of populations. One Health, the role of veterinarians in the diagnosis and prevention of zoonotic diseases, food security, food safety, food defense, meat hygiene, antimicrobial usage and prevention of antimicrobial resistance. Surgical and medical management of fertility including canine ovariohysterectomy. Pass/Fail only.
Instructional Contact Hours: (6 Lec, 3 Lab, 7 Crd)

VM 8214 - Small Animal Medicine (3 credits)
Clinical features and pathophysiology of common diseases of the endocrine, gastrointestinal, hepatobiliary, hematologic, urinary, and respiratory systems of dogs and cats. Diagnosis and treatment of these diseases. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (3 Lec, 3 Crd)

VM 8224 - Problem Solving in Public and Corporate Veterinary Practice (2 credits)
Public veterinary practice skills for veterinarians working in public and corporate practice. Communication with the media and stakeholders, methods for group decision-making, and frameworks for problem solving, including SWOT (Strengths, Weaknesses, Opportunities and Threats) Analysis, Risk Analysis, and the PESTLE framework. Government infrastructure and regulations related to infectious disease management in animal populations, emergency management, public health and animal welfare. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8244 - Zoo Mammal Comparative Morphology (1 credit)
Anatomy and physiology of zoo mammals. Functional evolutionary adaptations of morphological features of these mammals. Adaptations for locomotion, alimentation, thermoregulation and reproduction. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8254 - Functional Morphology of Birds (1 credit)
Anatomical features will be described that are unique to, or are characteristic of, each major group covered. Adaption and successful exploitation of habitat. Use of anatomical features and functions. Selected attributes of the groups natural history, members of the group common to the local and extended area, those commonly kept as pets. Pre-requisite: Graduate Standing required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: BMVS 5814

VM 8264 - Small Animal Nutrition (1 credit)
Practical feeding guidelines for companion animals. Special consideration also given to the relationship of diet to nutrient excesses and deficiencies that result in clinical disorders. Diagnosis, treatment, and prevention of metabolic disorders of companion animals will be discussed.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8294 - Small Animal Surgical Diseases and Techniques (2 credits)
Clinical features, pathophysiology and diagnosis of common small animal surgical diseases. Anatomically relevant structures, techniques, complications, and emergency resuscitation plans for common surgeries. Oncological and reconstructive surgeries. Preoperative, surgical and postoperative care. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 8360 - Food Animal Clinical Techniques (1 credit)
Techniques for physical examination, handling and restraint of food animals. Common diagnostic techniques including necropsy. Beef quality assurance programs including pharmaceutical and regulatory requirements. Pain relieving procedures. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Corequisite(s): VM 8615
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8364 - Veterinarians and Public Policy (2 credits)
Formulation and implementation of veterinary public policy at the international, national, state, professional association, and consumer level. Discussion of the formulation of legislation, regulation, guidance and resolutions. Roles of science, law, politics, economics, societal values, and stakeholder influence in forging veterinary public policy. Moral and ethical dimensions of veterinary public policy making. Focus on the formulation, role and impacts of public policy relative to the practice of private and public veterinary medicine. Pre: Graduate standing. Pass\Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8384 - Food Animal Nutrition (1 credit)
Practical feeding guidelines for food animals. Relationship of diet to nutrient excesses and deficiencies and resulting clinical disorders. Diagnosis, treatment and prevention of metabolic disorders of food animals. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8394 - Equine Nutrition (1 credit)
The course is designed to provide practical feeding guidelines for different classes of horses. The relationship between nutrition and clinical disorders of the horse is explored including their nutritional management. Students will be expected to complete a problem-solving nutrition project during the course.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8464 - Topics in Veterinary Public Health (2 credits)
Contributions of veterinary science to human health and well-being. Water quality and animal agriculture; antimicrobial use in animal populations and the impact on human health; environmental aspects of emerging and zoonotic infectious diseases; zoonoses of global importance; prioritization methods for infectious diseases; food safety, security and defense; socioeconomic impacts of animal disease; Human-Animal interaction/Human-Animal bond. Pass/Fail only. Pre: Graduate standing.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8484 - Food Animal Clinical Pharmacology (1 credit)
Therapeutic principles and their application for drugs in food animals. Drug labeling and extra-label drug use. Application of regulations regarding the Animal Medicinal Drug Use Clarification Act, Veterinary Feed Directive, growth promotants and implants. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8494 - Aquatic Medicine and Fish Health (2 credits)
The etiology, diagnosis, pathology, pathogenesis, chemotherapy, control and management of infectious and non-infectious diseases of aquatic organisms, especially pertaining to cultured food and tropical fish. Hands on experience with water quality evaluation, diagnostic techniques and the identification of common pathogenic organisms. Pre-requisite: Second year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: BMVS 5764

VM 8504 - Developing the Public Veterinary Practitioner (2 credits)
Principles of outbreak investigation, descriptive epidemiology, and disaster management in the control of infectious animal disease outbreaks; risk analysis; literature review methods; design of disease surveillance, prevention and control programs; principles of animal welfare; and global veterinary capacity building. Topics discussed within the context of state and federal government agencies, corporate/industry, and clinical institutions. Emphasis on communication, teamwork and leadership skills. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8524 - Equine Clinical Problem Solving (2 credits)
Equine clinical cases in a problem-oriented format. Causes and diagnoses of common equine clinical problems, diagnoses tests, test result interpretation, therapeutic regimen prescription, treatment monitoring plans. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8534 - Introduction to Clinical Research (2 credits)
Design of studies in veterinary related clinical and epidemiologic research, planning and implementation of experimental and survey data collection, management and analysis of data, evaluation of analysis and critical evaluation of published information. Pre: second-year standing in DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: BMVS 5564

VM 8564 - Breathing and Circulating (10 credits)
Structure, function and dysfunction of the cardiovascular, hemo-lymphatic and respiratory systems including gross, radiographic and microscopic anatomy; pathogenesis, pathophysiology, diagnosis, treatment and prevention of common diseases; general anesthesia of veterinary patients. Pass/Fail only.
Instructional Contact Hours: (9 Lec, 3 Lab, 10 Crd)

VM 8574 - Food Animal Theriogenology (1 credit)
Reproductive management for herds of food animal species including cattle, sheep, goats and pigs. Emphasis on clinical aspects of reproductive management. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8584 - Eating and Eliminating (10 credits)
Gastrointestinal, hepatobiliary, endocrine, renal, urogenital tract disease in domestic animals; congenital, degenerative, drug-induced, allergic, nutritional, neoplastic, immune-mediated, infectious, traumatic, toxic, vascular causes. Oral and abdominal anatomy. Nutrition. Clinical signs, diagnosis, treatment, and prevention of common diseases of domestic species. Pass/Fail only.
Instructional Contact Hours: (9 Lec, 3 Lab, 10 Crd)

VM 8594 - Wildlife Medicine (1 credit)
The course will include discussions on the regulations and ethics covering the rehabilitation and release of native wildlife. Lectures will cover the major infectious diseases, parasites, toxicities, injuries and other problems of wildlife. Common treatments, methods and equipment used to care for and rehabilitate these animals will be discussed. Species covered will include native mammals, wild songbirds, and raptors. Pre: second-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8604 - Small Animal Emergency Medicine (2 credits)
Topics and techniques for small animal emergency and critical care. Diagnosis and treatment of emergent systemic disease, traumatic injuries, toxicological emergencies and shock. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 8610 - Food Animal Population Medicine (2 credits)
Concepts of production diseases of food animals at the herd level. Includes diagnostic, therapeutic and preventions strategies. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8615 - Food Animal Medicine and Surgery (3 credits)
8615: This course will provide in-depth information on the common disorders of the major body systems of cattle, sheep, goats and pigs. Clinical signs, diagnostic tests, and treatments for disorders of individual animals will be emphasized. 8616: The course will include treatment of the individual animal and herd problems, preventative aspects of herd problems, and the regulatory and health aspects of herd management. Emphasis is on the production medicine aspects of herd and flock management. Pre: Third-year standing in the DVM curriculum.
Instructional Contact Hours: (3 Lec, 3 Crd)

VM 8664 - Beyond Private Practice: Veterinary Careers and Pathways (1 credit)
Exploration of veterinary career opportunities in federal and state governments; zoological, wildlife, aquatic, and conservation medicine; animal-related industries; academia and research; and emerging opportunities. Focus on pathways and processes used to determine career choice. Emphasizes development of resumes, interviewing and negotiating for public and corporate careers. Pass\Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8665 - Becoming a Veterinary Professional (2 credits)
Introductory professional development for veterinarians, including the principles of oral clinical communication (communication with clients, colleagues and general public), clinical written communication (medical records, case reports, referrals), collaboration (inter and intra professional), reflective practice, intercultural awareness, ethics and law, animal welfare, career development, professionalism, foundational practice management, literature seeking and evidence based medicine, and management of self, team, finance and career. Enrolled in DVM degree. Pre: Graduate standing. P/F only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8666 - Becoming a Veterinary Professional (2 credits)
Further exploration of professional development with an emphasis on more difficult communication topics, revisiting career development, finance, legal and ethical issues at a deeper level. Create a community and social context to provide, identify and facilitate learning from professional role models. Enrolled in a DVM degree. Graduate standing. P/F only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8667 - Becoming a Veterinary Professional (2 credits)
Build a professional identity through exploration of medical errors, team communication skills, communication of diagnostic and treatment plan, outcomes and financial consideration. Professional development through exposure to multiple professional, ethical and cross-cultural scenario and cases. Enrolled in a DVM degree. Graduate standing. P/F only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8670 - Special Topics in Equine Clinical Practice (2 credits)
Current and in-depth information on common diseases of horses including their pathophysiology, diagnosis, treatment, clinical management and control. Advanced topics in neurology, gastroenterology, ophthalmology, urology, oncology, and dermatology. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8680 - Equine Clinical Practice: Breathing, Circulating and Moving (2 credits)
Current and in-depth information on common diseases of horses including their pathophysiology, diagnosis, treatment, clinical management and control. Advanced topics in the musculoskeletal, respiratory and cardiac systems. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8690 - Equine Clinical Practice: Breathing, Circulating and Moving Lab (1 credit)
Development of clinical skills for diagnosis of diseases that affect the equine musculoskeletal, respiratory and cardiac systems. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8696 - Equine Medicine and Surgery (3 credits)
These courses provide in-depth information about diseases affecting horses including pathophysiology of prominent diseases, methods of diagnosis, clinical management, and treatment. 8695: Advanced topics in diseases of the equine cardiopulmonary and musculoskeletal systems. 8696: Advanced topics in the equine nervous, gastrointestinal, dermal, and urinary systems. Pre: Third-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

VM 8704 - Veterinary Cytopathology (1 credit)
Introduction to cytopathology and sample collection. Microscopic review of cytological samples from common neoplastic, inflammatory and infectious disorders. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8714 - Small Animal Oncology (2 credits)
Study of pathophysiology, diagnosis, staging and management of cancer in small animals. Critical evaluation of the primary veterinary oncology literature. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 8724 - Equine Diagnostic Techniques for the Musculoskeletal and Respiratory Systems (1 credit)
Diagnostic techniques commonly used in equine practice involving the musculoskeletal and respiratory systems. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8734 - Beef Cattle Medicine and Production (1 credit)
Management and medical conditions affecting production in beef cattle. Common procedures in beef practice. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8744 - Dairy Cattle Medicine and Production (1 credit)
Management and medical conditions affecting production in dairy cattle. Common procedure in dairy practice. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8774 - Food Animal Clinical Reproduction (1 credit)
Techniques for clinical evaluation of the reproductive tract of individual animals in herds of food animals including cattle, sheep, and goats. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8784 - Decision Making in Veterinary Pharmacology (2 credits)
Principles of therapeutic decision making with emphasis on selection of appropriate drug, the risks and benefits of drug treatment, monitoring the course of therapy in an individual patient, and the economic impact of therapeutic decisions including the cost of therapy costs of drug residues and adverse drug reactions. Study of drugs based on therapeutic objectives and the effect of the disease process on pharmacokinetics and pharmacodynamics.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8794 - Equine Podiatry (3 credits)
Anatomy, physiology, and biomechanics of the distal limb of the horse. Diagnosis, including radiology, and treatment of common diseases of the equine digit. Principles and practice of farriery. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 3 Lab, 3 Crd)

VM 8804 - Small Animal Physical Rehabilitation and Complementary Medicine (1 credit)
Physical rehabilitation, conditioning, and complementary therapies in small animals. Therapeutic and conditioning exercises, acupuncture, photobiomodulation, electrical stimulation, therapeutic ultrasound, nutrition and nutraceuticals. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8810 - Care Forward (2 credits)
Principles of wellness in health care professionals. Strategies for self-care, development of personal financial management, and healthy inter-professional and interpersonal relationships. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8814 - The Next Equid (3 credits)
Development of knowledge and skills for diagnosing and managing reproductive tract conditions of the horse including breeding soundness and cycles, pregnancy diagnosis, failure to breed, and parturient emergencies. Neonatal medicine including diagnosis, treatment and management of sick foals, and preventive care. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 3 Lab, 3 Crd)

VM 8824 - Moving (9 credits)
Structure and function of musculoskeletal systems required for locomotion. Diagnosis and treatment of common diseases of domestic animals that limit function of movement. Pain and pain management. Pass/Fail only. Design/Lab Studio.
Instructional Contact Hours: (7 Lec, 3 Lab, 9 Crd)

VM 8834 - Food Animal Reproduction Techniques (1 credit)
Transrectal palpation skills and ultrasonography in the non-pregnant cow to assess uterus and ovarian structures. Reproductive tract scoring in the heifer, semen handling and AI techniques, and bull breeding soundness examination. Diagnosis of infertility and abortion. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design studio/lab.
Corequisite(s): VM 8574
Instructional Contact Hours: (2 Lab, 1 Crd)

VM 8844 - Applied Veterinary Diagnostics (2 credits)
Case based applications of veterinary diagnostic testing. Interpretation of gross lesions, radiographic images, laboratory data, and ultrasound images relevant to body systems. Clinical and diagnostic reasoning to determine clinically significant abnormalities. Pass/Fail only.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 8864 - Clinical Reptile Medicine (1 credit)
Anatomy, physiology and husbandry of four reptilian groups. Diagnostic tests, hospital care, anesthesia, analgesia, critical care, and surgical treatment of common diseases and injuries of reptiles. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8874 - Ferret Medicine and Surgery (1 credit)
A comprehensive study of domestic ferret from the veterinary perspective. Topics include husbandry/management, common diseases and surgical procedures. The course consists of lectures and laboratories. Pre: third year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8884 - Traditional Chinese Veterinary Medicine (1 credit)
History and fundamental theories of traditional Chinese veterinary medicine (TCVM). Assessment, diagnosis and treatment of disease using these theories. Diagnostic techniques and their interpretation associated with TCVM including the use of meridians. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8894 - Small Animal Ophthalmology and Neurology (1 credit)
Clinical features and pathophysiology of common diseases of the eyes and nervous system of dogs and cats. Diagnosis and treatment of ocular and neurological diseases. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 8914 - Small Animal Dentistry (2 credits)
Normal dental anatomy, diagnosis of common dental/oral diseases of dogs and cats including radiology. Complete oral health assessment and treatment. Techniques for tooth extraction, regional nerve blocks, mandibular fractures, interceptive and restorative dentistry. Pre: 3rd year standing in the DVM program. Pass/Fail only. Design Lab/Studio.
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 8984 - Special Study (1-19 credits)
Instructional Contact Hours: Variable credit course

VM 9004 - Avian Medicine and Surgery (1 credit)
Course is designed to provide students with basic information and skills necessary for the diagnosis and treatment of disorders of avian species with an emphasis on pet birds. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9014 - Advanced Diagnostic Imaging (1 credit)
This course is designed to introduce students to the basic principles of and applications for advanced diagnostic imaging in veterinary medicine. Topics will include computed tomography, magnetic resonance imaging, nuclear imaging, linear tomography, fluoroscopy, and ultrasonography. Tours of imaging facilities at the VMRCVM Teaching Hospital and Montgomery Regional Hospital will be available. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9024 - Equine Sports Medicine and Rehabilitation (2 credits)
Sports medicine, rehabilitation, and complementary medicine in horses. Examination and diagnosis of performance limiting musculoskeletal injuries and cardiorespiratory conditions in the equine athlete. Therapeutic and rehabilitation treatment options including therapeutic shoeing, soft tissue manual therapies, conditioning exercises, acupuncture, chiropractic, photobiomodulation, electrical stimulation, underwater treadmill and hydrotherapy; regenerative medicine and nutrition including herbal medicines. Regulations regarding use of medications. Pre: 3rd year standing in the DVM program. P/F only. Design Lab Studio
Instructional Contact Hours: (1 Lec, 2 Lab, 2 Crd)

VM 9034 - Advanced Small Animal Surgery (2 credits)
This course concentrates on the study of soft tissues and orthopedic surgical principles and methods that are applicable to small animal practice. Emphasis is placed on the identification of disease conditions treatable by surgical therapy, applicable surgical methods, and expected outcome. Detailed, step-by-step, surgical procedures will be presented prior to student performance in the complementary laboratory in the Advance Small Animal Surgery Laboratory course (VM 9134).
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 9044 - Food Animal Clinical Problem Solving (2 credits)
This course will present food animal clinical cases in a problem oriented format. Although the majority of the problems presented will begin with the individual animal case, emphasis will be placed on control and prevention in the flock or herd. Aspects of outbreak/disease investigation, production medicine, economics, and epidemiology will also be utilized. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 9064 - Advanced Histopathology (1 credit)
Pathology centering on reaction of organs, tissues and cells at the light microscopic level is presented in a case-based format. Emphasis will be placed on classic tissue and cellular response to injury and will incorporate information and correlate disease mechanisms presented in prerequisite courses. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (3 Lab, 1 Crd)

VM 9074 - Goat and Sheep Medicine (1 credit)
This is an in-depth treatment of health and management as well as diseases of goats and sheep. Production cycles, management concerns, as well as routine preventative care are covered as well as management of traumatic, infectious, and toxic disease problems. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9085 - Emerging Infectious Diseases (1 credit)
Stand-alone, fully on-line, asynchronous distance and distributed learning course, accessible as streaming videos on the Internet or on CDs. 9085: The course defines and discriminates amongst numerous factors influencing the emergence of infectious diseases. Selected emerging food-borne, bacterial, viral, zoonotic diseases of animals and humans are described and analyzed. 9086: The course expands the pathology of emerging infectious diseases. Additional viral, parasitic and zoonotic diseases of animals and humans are described and analyzed. Xenotransplantation is also discussed from the perspective of zoonotic diseases. Third year standing in the DVM curriculum, or good standing in a graduate studies program is required.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: BMVS 5005

VM 9094 - Advanced Veterinary Public Health (1 credit)
Consideration of the organization and delivery of Veterinary Public Services at the local, state, national and international levels including zoonoses surveillance, investigation and response to disease outbreaks, biological warfare and terrorism, response to natural emergencies and disasters, and public health policy formulation. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)
Course Crosslist: BMVS 6564

VM 9104 - Veterinary Practice Business Management (3 credits)
Core business management, marketing and entrepreneurship concepts for veterinary practice. Requirements, risks, rewards and ethical considerations of practice ownership. Assessment, analysis and solutions for business problems including financial, legal and organizational. Business leadership skills. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (3 Lec, 3 Crd)

VM 9124 - Equine Theriogenology II (1 credit)
Advanced equine theriogenology. Reproductive procedures and latest techniques of assisted reproductive technology. Collection of semen/embryos and processing/shipment of each. Surgical management of reproductive disorders will be presented. Prerequisite: Third year standing in the DVM curriculum.
Instructional Contact Hours: (3 Lab, 1 Crd)

VM 9134 - Advanced Small Animal Surgery Laboratory (1 credit)
Principles and skills for entry-level surgery. Applied practice in surgical principles and techniques, including ovariohysterectomy, orthopedic, ophthalmic procedures.
Instructional Contact Hours: (3 Lab, 1 Crd)

VM 9144 - Problem Solving in Small Animal Medicine (2 credits)
Problem solving skills for diagnoses of medical diseases in small animal patients. Problem-oriented case material for diagnoses evaluation and therapeutic options. Pre-requisite: Third-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)

VM 9174 - Equine Neonatal Medicine (1 credit)
Normal parturient events, disease that affect neonatal foals, and the diagnostic and treatment options currently available to practitioners. Emphasis placed on problem oriented approach through evaluation of case examples. Pre-requisite: Third-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9224 - Pocket Pet Medicine (1 credit)
Care and management of companion exotic species including rats, mice, gerbils, hamsters, guinea pigs, chinchillas, rabbits, ferrets, sugar gliders, and hedgehogs. Common clinical problems including major infectious and non-infectious diseases, nutritional problems and trauma. Diagnostic approaches, medical and surgical treatments, including anesthesia and vaccination protocols. Pre: 3rd year standing in the DVM program. Pass/Fail only.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9244 - International Veterinary Medicine (2 credits)
Overview of international veterinary activities. Understanding of the role of governmental agencies, inter-governmental and non-governmental organizations in international relations, development, relief work, conversation, disease control and prevention, and trade. Understanding of the legal authority of binational agreements and international treaties. Training in intercultural communications, negotiation and conflict resolution. Review of current global issues. Pre: third-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 2 Crd)
Course Crosslist: BMVS 6594

VM 9254 - Small Animal Theriogenology (1 credit)
This course deals with the normal reproductive function and management in the dog and cat. Diagnosis and management of reproductive diseases are considered. Pre: second-year standing in the DVM curriculum.
Instructional Contact Hours: (1 Lec, 1 Crd)

VM 9264 - Small Animal Community Practice Clerkship (4 credits)
Senior veterinary students will be trained in clinical medicine and surgery in a private veterinary practice setting under the direction of experienced veterinary practitioners. Opportunities will exist to participate in the routine aspects of veterinary practice, to interact with clients and clinic personnel, to improve surgical and diagnostic skills, and to observe and understand business management activities. Fourth year standing in the DVM curriculum required.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9324 - Pub Hlth Infect Contrl & Prev (3 credits)
Assessment, policies, and procedures for control and prevention of infectious diseases in communities and populations. Sources, transmission mode, and local community to international dissemination of infectious disease agents; antimicrobial and chemical resistance; vaccine development, safety, and coverage; community and hospital based needs and interventions; and regulatory frameworks. Pre: Graduate Standing required.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5324

VM 9334 - Principles Infectious Diseases (3 credits)
Principles of infectious diseases important for local, national, and global public health. Bacterial, viral, fungal, and parasitic pathogens; mechanisms of disease; host immune response to pathogens. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5334

VM 9344 - Neglected and Emerging Infectious Diseases in Public Health (3 credits)
Neglected infectious diseases and their association with marginalized populations and factors including poverty, social and health inequities, water, sanitation and hygiene, and urbanization. Critical factors for emergence/re-emergence of infectious diseases in populations and regions, including geopolitical challenges, zoonotic and vector impacts. Evaluate studies and global responses to neglected and emerging infectious diseases to inform the development of One Health interventions. Pre: Graduate standing.
Instructional Contact Hours: (3 Lec, 3 Crd)
Course Crosslist: PHS 5344

VM 9404 - Specialty Medicine Clerkship (4 credits)
In-depth study of cardiology and neurology. Instruction will be case-based in the Veterinary Medical Teaching Hospital. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9434 - Small Animal Internal Medicine Clerkship (4 credits)
Care of local area animal sick animals, routine vaccinations and yearly physical examinations, and referral internal medicine cases. Students participate in emergency and intensive care unit services. Students are given primary patient responsibility, allocated time for daily rounds and individual case study. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9454 - Veterinary Ophthalmology Clerkship (4 credits)
Diseases of the eye in several species. Examination and treatment of local and referred patients with eye problems. Students will be given primary patient responsibility. May be repeated for a maximum of 8 credits. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)
Repeatability: up to 8 credit hours

VM 9504 - Large Animal Clinical Services Clerkship (4 credits)
Principles of large animal medicine and surgery including acquisition of an unbiased medical history, performance of a complete physical examination and knowledge of various diagnostic, therapeutic and surgical procedures performed on large animal patients admitted to the V.M.T.H. Students will work with large animal medical and surgical patients, attend daily ward rounds and have additional time for individual study.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9534 - Production Management Medicine Clerkship (4 credits)
Students will be introduced to clinical problems principally as they involve populations of animals within their production environment. The emphasis will be directed to problem identification, solution, and prevention. Students will handle, examine, and treat animals within their environment. Students will also attempt to determine environmental factors that contribute to the incidence of disease affecting individual animals and populations of animals, and assess how these factors can be most economically altered to prevent recurrence of the problem.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9544 - Equine Medical Center Clerkship (4 credits)
Clinical experience in both equine medicine and surgery by working with the faculty and clinical support staff in the management of horses referred by veterinarians for elective or emergency care. This will include patient admission and discharge responsibilities, pre- and post-operative patient care, routine and intensive medical surgical care. May be repeated for a maximum of 8 credit hours. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)
Repeatability: up to 8 credit hours

VM 9604 - Small Ruminant Clerkship (4 credits)
Detailed clinical exercises, discussion sessions, and problem-solving exercises concerning the biology, management diseases, and therapeutics of sheep, goats, llamas, and alpacas. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9614 - Small Animal Surgery Clerkship (4 credits)
Supervised clinical experience in diagnostics, pre-operative preparation, surgery and post-operative care of dogs and cats admitted through the Teaching Hospital for surgical problems. Correlative and communicative skills will be stressed. Patient care is a prime concern. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9624 - Anesthesiology Clerkship (4 credits)
Clinical experiences in comparative anesthesiology. Prospective and retrospective rounds and case discussions regarding teaching hospital patients. Additional time will be available for individual study. Pre: fourth year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9634 - Radiology Clerkship (4 credits)
Practical training in the production of diagnostic quality radiographs of various body parts of large and small animals with attention given to radiation safety and optimal radiographic positioning and technique; development of skills in radiographic interpretation.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9644 - Small Animal Private Practice Clerkship (4 credits)
Training of senior veterinary students in clinical medicine and surgery in the small animal private practice setting under the direction of experienced veterinary practitioners. Opportunities to participate in the routine of veterinary practice, to interact with clients and clinic personnel, to improve surgical and diagnostic skills, and to observe clinic management. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)
Repeatability: up to 8 credit hours

VM 9714 - Government and Corporate Veterinary Medicine Clerkship (4 credits)
Develop and expand an awareness and understanding of career opportunities in veterinary medicine other than those in private clinical practice.
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)

VM 9724 - Laboratory Services Clerkship (4 credits)
To provide senior veterinary students with experience in the necropsy service of the Veterinary Teaching Hospital by working on actual case material; to give students an overview of laboratory support services of the hospital.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9744 - Morphologic Pathology Elective Clerkship (4 credits)
This course focuses on the details of performing animal necropsies and interpreting the lesions that may be found. Sampling and preparation techniques are considered for the preparation of histopathological specimens. Correlation of laboratory results with gross and histopathological findings is stressed and a final diagnostic report is prepared.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9764 - Independent Study/Research Elective (4 credits)
Provides the opportunity for students considering a career in public practice (Government/Corporate) to obtain in-depth experience in their focus area. Also allows students enrolled in the DVM/MS or DVM/PhD program to pursue research or other objectives in specified areas. Experiences will be tailored to the students area of interest.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9784 - Government and Corporate Veterinary Medicine Elective Clerkship (4 credits)
Develop and expand an awareness and understanding of career opportunities in veterinary medicine other than those in private clinical practice. (This course may be taken three times for a maximum of 12 semester credit hours).
Prerequisite(s): VM 9714
Instructional Contact Hours: (3 Lec, 3 Lab, 4 Crd)
Repeatability: up to 12 credit hours

VM 9794 - Center for Government and Corporate Veterinary Medicine Clerkship (4 credits)
The three-week clerkship provides hands-on involvement in the public practice of veterinary medicine, for the purpose of skill building, networking, and understanding/celebrating diversity. CGCVM faculty serve as mentors, structure opportunities, and provide debriefing following experiences. Government/corporate veterinarians in the Washington DC Metropolitan region, individually selected to match the career focus of the students, serve as advisors and consultants. Case studies will be used to explore current veterinary issues. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9804 - Food Animal Private Practice Clerkship (4 credits)
Training of senior veterinary students in clinical medicine and surgery in the food animal private practice setting under the direction of experienced veterinary practitioners. Opportunities to participate in the routine of veterinary practice, to interact with clients and clinic personnel, to improve surgical and diagnostic skills, and to observe clinic management. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9814 - Equine Private Practice Clerkship (4 credits)
Training of senior veterinary students in clinical medicine and surgery in the equine private practice setting under the direction of experienced veterinary practitioners. Opportunities to participate in the routine of veterinary practice, to interact with clients and clinic personnel, to improve surgical and diagnostic skills, and to observe clinic management. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9824 - Mixed Species Private Practice Clerkship (4 credits)
Training of senior veterinary students in clinical medicine and surgery in the private practice setting under the direction of experienced veterinary practitioners. Opportunities to participate in the routine of veterinary practice, to interact with clients and clinic personnel, to improve surgical and diagnostic skills, and to observe clinic management. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9834 - Equine Theriogenology Clerkship (4 credits)
Allows the interested student to pursue off-campus training in equine theriogenology beyond that provided in earlier theriogenology courses (VM 8374, 8514, 9124). Students will work on cases involving breeding management and abnormal reproductive function and will become familiar with methods to correct or treat these problems. Pre: fourth-year standing in the DVM curriculum.
Instructional Contact Hours: (2 Lec, 6 Lab, 4 Crd)

VM 9964 - Practicum/ Clerkship (1-19 credits)
Instructional Contact Hours: Variable credit course

Public Health Major

Program Curriculum

Code	Title	Credits
Degree Core Requirements		
HNFE 1004	Foods, Nutrition And Exercise	3
PHS 1514	Personal Health	3
PHS 2004	Introduction to Public Health	3
HNFE 2664	Behavioral Theory in Health Promotion	3
PHS 3014	Introduction to Environmental Health	3
PHS 3074	Public Health Professional and Practicum Prep	1
PHS 3534	Drug Education	3
PHS 3634	Epidemiologic Concepts of Health and Disease	3
SOC 4704	Medical Sociology	3
or PHS 3654	Equity in Rural Health	
PHS 4044	Public Health Policy and Administration	3
PHS 4054	Concepts in One Health	3
PHS 4064	Modeling Infectious Diseases	3
PHS 4074	Practicum in Public Health	2
ADV 2134	Introduction to Health Communication	3
or ADV 4324	Issues in Health Communication	
Subtotal		39
Major Requirements		
PHS 1004	Public Health First Year Experience	1
PHS 4014	Public Health Program Planning and Evaluation	3
Free Electives		**32**
Subtotal		36
Pathways to General Education		
Pathways Concept 1 - Discourse		
ENGL 1105	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
ENGL 1106	First-Year Writing (Pathway 1f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01F))	3
Pathway 1a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G01A)		3
Pathways Concept 2 - Critical Thinking in the Humanities		
Pathway 2 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G02)		6
Pathways Concept 3 - Reasoning in the Social Sciences		
PSYC 1004	Introductory Psychology (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03))	3
SOC 1004	Introductory Sociology (Pathway 3 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G03))	3
Pathways Concept 4 - Reasoning in the Natural Sciences		
BIOL 1105	Principles of Biology (Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	3
BIOL 1106	Principles of Biology (Pathway 4 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G04))	3
Pathways Concept 5 - Quantitative and Computational Thinking		
MATH 1014	Precalculus with Transcendental Functions (Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F))	6
STAT 3604	Statistics for Social Science (Pathway 5a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05A))	3
or STAT 3615	Biological Statistics	
Pathway 5f (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G05F)		3
Pathways Concept 6 - Critique and Practice in Design and the Arts		
Pathway 6a (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06A)		3
Pathway 6d (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G06D)		3
Pathways Concept 7 - Critical Analysis of Identity and Equity in the United States		
Pathway 7 (https://catalog.vt.edu/course-search/?attrs_pathways=attrs_pathways_G07)		3
Total Credits		**120**

Satisfactory Progress Toward Degree

1. After having attempted 36 semester credits (including transfer, advanced placement, and advanced standing) students must have passed at least 12 semester credits of Pathways to General Education.
2. After having attempted 72 semester credits (including transfer, advanced placement and advanced standing) students must have an in major GPA of 2.0 or higher and must have successfully completed PHS 1514, PHS 2004, HNFE 1004, HNFE 2664 and STAT 3604/STAT 3615.
3. After having attempted 96 semester credits (including transfer, advanced placement and advanced standing) students must have an overall GPA of 2.0 or higher and must have successfully completed PHS 3534, PHS 3634, PHS 3014 and PHS 4014.

Graduation Requirements

Students must maintain a minimum of 2.0 cumulative GPA and earn a grade of C- or better in each of the following courses in order to qualify for graduation. The courses listed are used to calculate a students in-major GPA:

Code	Title	Credits
PHS 1514	Personal Health	3
PHS 2004	Introduction to Public Health	3
PHS 3014	Introduction to Environmental Health	3
PHS 3534	Drug Education	3
PHS 3634	Epidemiologic Concepts of Health and Disease	3
PHS 4014	Public Health Program Planning and Evaluation	3
SOC 4704	Medical Sociology	3
or PHS 3654	Equity in Rural Health	
PHS 4044	Public Health Policy and Administration	3
PHS 4054	Concepts in One Health	3
PHS 4064	Modeling Infectious Diseases	3
HNFE 1004	Foods, Nutrition And Exercise	3
HNFE 2664	Behavioral Theory in Health Promotion	3
STAT 3615	Biological Statistics	3
or STAT 3604	Statistics for Social Science	
ADV 2134	Introduction to Health Communication	3
or ADV 4324	Issues in Health Communication	
PHS 1004	Public Health First Year Experience	1

Foreign Language Requirement

Students who did not successfully complete at least two years of a single foreign, classical, or sign language during high school must successfully complete six semester hours of a single foreign, classical, or sign language at the college level. Courses taken to meet this requirement do not count toward the hours required for graduation.

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